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ABSTRACT

These instructor materials for an aviation maintenance technology course contain four instructional modules. The modules cover the following topics: identifying basic components of aircraft, performing aircraft cleaning and corrosion control, interpreting blueprints and drawing sketches, identifying structural materials, and performing basic material processes. Each module contains some or all of these nine basic components--a module introduction and objective, performance objectives, instructor's module implementation guide, technical information supplements, workbook supplements, project guides, theory test, answers to theory test and workbook supplements, and a practical test. These materials were developed through a cooperative effort of airframe and powerplant mechanics, general aviation industry representatives, Federal Aviation Administration representatives, and vocational educators in Oklahoma to provide a comprehensive program in aviation maintenance technology. (KC)

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AVIATION MAINTENANCE TECHNOLOGY

GENERAL

G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE

INSTRUCTOR MATERIAL

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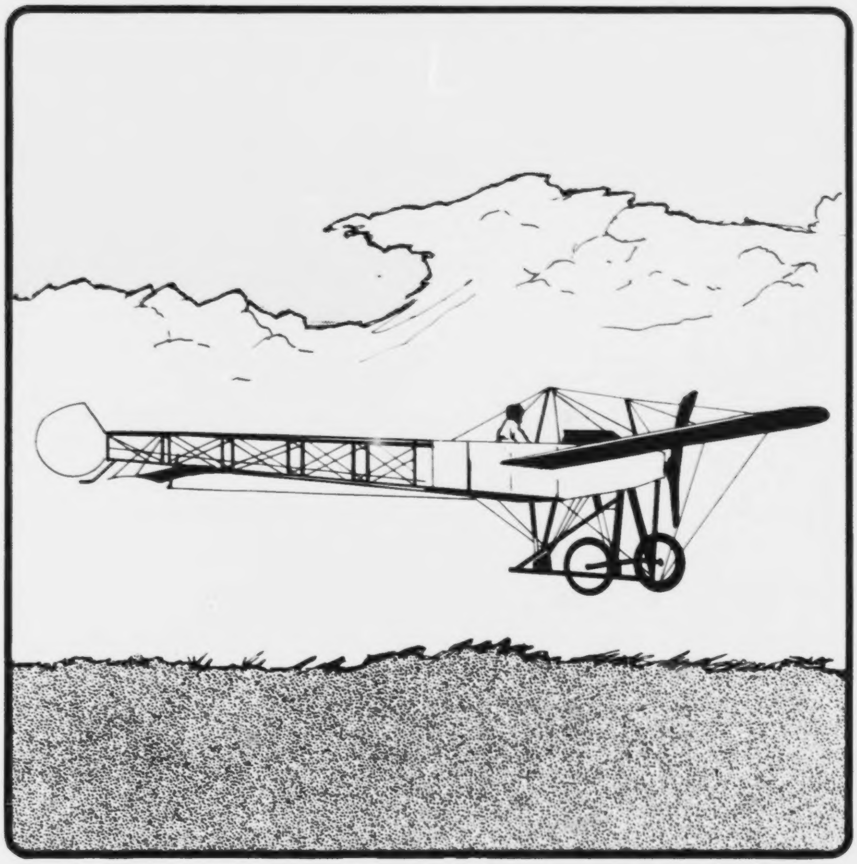
MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY BASIC COMPONENTS OF AIRCRAFT
G102-A



CLYDE CESSNA'S "SILVER WINGS"

Clyde Cessna was one of the pioneers of aviation. More than half a century ago (1911) he was successful in taking-off, sustaining flight and landing in an airplane of his own design and manufacture. The airplane was named "Silver Wings." Clyde Cessna had made twelve previous unsuccessful flights in it before his "lucky" thirteenth try.

On the day of his triumph, Clyde Cessna landed on a lonely salt flat in Oklahoma, taxied up to where his brother Roy was standing, and happily shouted "She flies like a Hawk!" Thus Clyde Cessna marked his place in the history of aviation. Today, the largest manufacturer of general aviation in the world bears his name.

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GENERAL
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MODULE CONTENTS

A. Introduction and Module Objective

B. Specific Objectives

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  1. Technical Information Supplement #1 - Terms and Definitions
  2. Technical Information Supplement #2 - Similarities of Aircraft and Birds
  3. Technical Information Supplement #3 - Four Forces of Flight
  4. Technical Information Supplement #4 - Parts and Structure of an Aircraft
  5. Technical Information Supplement #5 - How an Aircraft is Controlled

E. Transparency Masters

  1. TM #1 - How Birds and Aircraft Fly
  2. TM #2 - The Four Forces of Flight
  3. TM #3 - The Main Parts of an Airplane
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INTRODUCTION

As an aircraft mechanic you will need to know the basic components of aircraft structures. This knowledge is necessary in order to carry out the many maintenance tasks you will be required to perform.

MODULE OBJECTIVE

After completion of this module, you will be able to identify basic components of aircraft structures, and list and explain the four forces of flight. You will also be able to select facts related to basic components of aircraft structures and the functions and operation of aircraft controls. You will demonstrate this knowledge by completing the procedures outlined in the workbook supplements. You will further demonstrate this knowledge by scoring 85 percent on the module theory test.

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SPECIFIC OBJECTIVES

After completion of this module, you will be able to:

1. Match terms related to basic components of aircraft structures to their correct definitions. (1)	Technical Supplement #1
2. Complete statements related to the ways in which modern aircraft are similar to birds. (1)	Technical Supplement #2
3. Define the four forces of flight. (1)	Technical Supplement #3
4. Identify the basic components of aircraft structures. (2)	Technical Supplement #4
5. Select true statements related to the basic components of an aircraft structure. (1)	Technical Supplement #4
6. Select true statements related to the functions of aircraft controls and how they are operated by the pilot. (1)	Technical Supplement #5

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Booklet -- Cessna Air Age Education booklet The Flying Machine: First Cousin to the Bird.

(NOTE: This is available from Cessna Aircraft Co., Air Age Education, P.O. Box 1521, Wichita, Kansas 67201.)

B. Films

1. How Airplanes Fly.
2. Put Wings On Your Career.

(NOTE: These are available from the FAA Film Service, Care of Modern Talking Picture, Inc. 5000 Park Street North, St. Petersburg, Florida 67201.)

II. Implementation Suggestions

(NOTE: Have students read material related to the Specific Objectives. Make transparency masters of Instructional Supplement #1.)

Estimated Teaching Time		Theory	Lab
Objective 1	Explain terms and definitions. Have students review Technical Information Supplement #1. Show film Put Wings On Your Career.		
Objective 2	Explain the similarities between birds and modern aircraft. Have students review Technical Information Supplement #2. Use Transparency Master #1 and Instructional Supplement #1.		
Objective 3	Explain the four forces of flight. Have students review Technical Information Supplement #3. Use Transparency Master #2.		
Objective 4	Point out the basic components of aircraft structures. Have students review Technical Information Supplement #4. Use Transparency Master #3.		

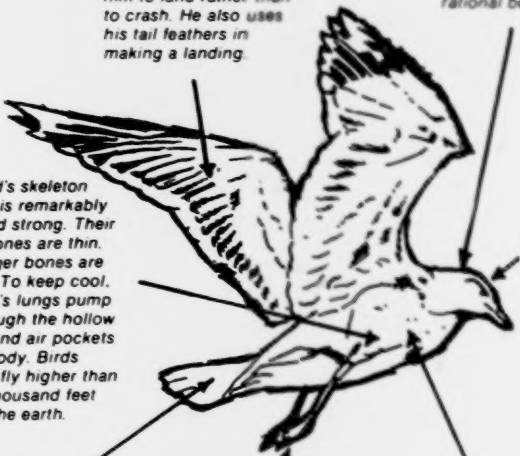
INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 5	Explain the basic components of an aircraft structure. Have students review Technical Information Supplement #4.		
Objective 6	Explain the functions of aircraft controls and how they are operated by the pilot. Have students review Technical Information Supplement #5. Use Transparency Masters #4 and #5 and transparency masters made from Instructional Supplement #2. To explain the axes of rotation, use a model airplane and dowel rods to construct an example of the Axes of Rotation Transparency Master. This model can be modified throughout the Airframe and Powerplant courses for several demonstrations. Show film How Airplanes Fly.		

INSTRUCTIONAL SUPPLEMENT #1 - The Bird Versus the Modern Airplane

THE BIRD

Man is an important part of nature. Because of his top position in nature's own scale, he has been given the resources to improve on the functions of certain creatures of nature. Take flying, for instance. Man's concept of flying naturally began with the bird. At first, his flying attempts were awkward and inferior to the bird's. But now, man flies with greater speed, precision and skill than the best flying bird nature ever created. So you can compare for yourself, here's a fair appraisal of a bird's flying system:



1. *When a bird lands, he spreads his wings and raises them at the same time. This captures a cushion of air (like a parachute) and slows the bird down, allowing him to land rather than to crash. He also uses his tail feathers in making a landing.*

2. *Birds have small brains. This may well be the reason that they fall prey to hunters, fly into stationary objects and, in general, show a pretty low regard for rational behavior.*

3. *The bird's skeleton (frame) is remarkably light and strong. Their small bones are thin. The larger bones are hollow. To keep cool, the bird's lungs pump air through the hollow bones and air pockets in his body. Birds seldom fly higher than a few thousand feet above the earth.*

4. *Birds can see very well, indeed. As a matter of fact, they can see landmarks more than 60 miles distant. No one knows, however, how they navigate. But they do.*

5. *Notice the tail. Tail feathers help the bird control his own flight by executing various maneuvers. He uses it for balance and for changing directions. Some birds spread their tail feathers to gain lift.*

6. *The bird's legs and feet are his landing gear. In flight, he pulls them up close to his body (to reduce drag). In landing, his feet function as brakes and his legs cushion his body against landing shock.*

7. *Some birds can fly great distances, non stop, at speeds up to 70 mph. Their "motor" is the pectorals (chest muscles) that move the wings. Fuel (energy) is provided by the large amount of food they consume at frequent feedings.*

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INSTRUCTIONAL SUPPLEMENT #1 - The Bird Versus the Modern Airplane (Continued)

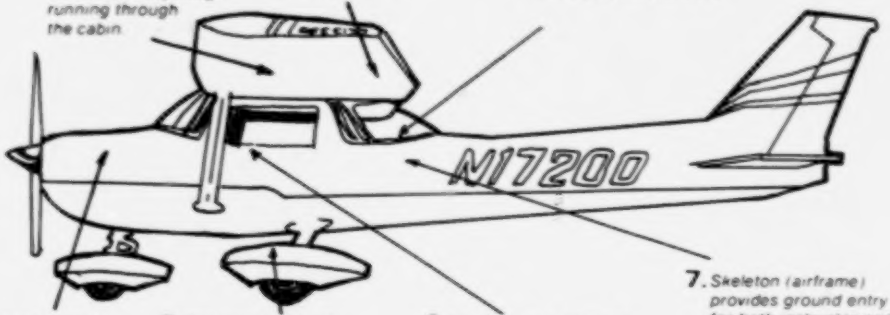
THE AIRPLANE (CESSNA 150)

The airplane has borrowed all it can from the bird and gone on from there. The modern airplane has greatly refined all the systems used in flight. While the pilot of a modern airplane has the opportunity to precisely manage every aspect of flight through the use of controls and instruments, the bird must rely on instinct. He is still a seat-of-the-pants flier. Not so with the pilot of a modern airplane. He has lots more to work with. As a result, he can do much better than "fly like a bird."

1. *Steady, smooth flight control of the Cessna 150 is provided by the placement of the wing which puts the center of lift above the center of gravity. Like a bird. And the wing also shades the cabin, allows fuel to flow to the engine by gravity and eliminates humps on the floor caused by wings running through the cabin.*

2. *Slowing down for a landing is aided by Para-Lift flaps. They are the slotted type and provide greater flexibility for operation in and out of small fields . . . steeper approaches, shorter landing and quicker takeoffs. Para-Lift flaps produce 55% greater lift than plain flaps.*

3. *Superb visibility. Omni-Vision provides 360° visibility from each seat. Windows all the way around the cabin give the interior a bright, open, uncramped feeling. Optional overhead skylights are an extra aid in turns and traffic areas. Tinted windshields and side windows also available.*



4. *Muscle power is provided by a 100 horsepower engine. It is especially designed for dependability and reliability. (Recommended time between overhauls is 1800 hours). It is lightweight and has all the vibration possible engineered out. The rest is cushioned by rubber engine mounts to make the cabin quiet, smooth and comfortable. It's unlike the engine in your car in several respects. One is that it does not have a radiator.*

5. *The main 150 landing gear is made of tough steel tubing. It is called "Land-O-Matic" because it does so much of the landing job for the pilot. It is engineered to flex in a way that will absorb and dissipate landing shocks before they reach the airplane itself (airframe). The third (nose) wheel in front makes a three-point tricycle arrangement out of the Land-O-Matic system.*

6. *The 150 brain center is an "all pro" panel. Basic "T" grouping of flight instruments builds correct training habits in the student pilot from his first hour onward. Controls are conveniently located for student and instructor and the center panel accepts a complete radio and navigation package.*

7. *Skeleton (airframe) provides ground entry for both instructor and students, each through his own wide door. Seats fold down and travel on seat tracks providing wide range of travel and easy access to rear of cabin and baggage area. The 24 cu. ft. carpeted baggage area has a capacity of 120 lbs. Optional child's seat may be installed. Cabin heating and ventilation assures comfortable climate all year with panel-mounted controls. Windows on both sides swing open for maximum ventilation even in flight.*

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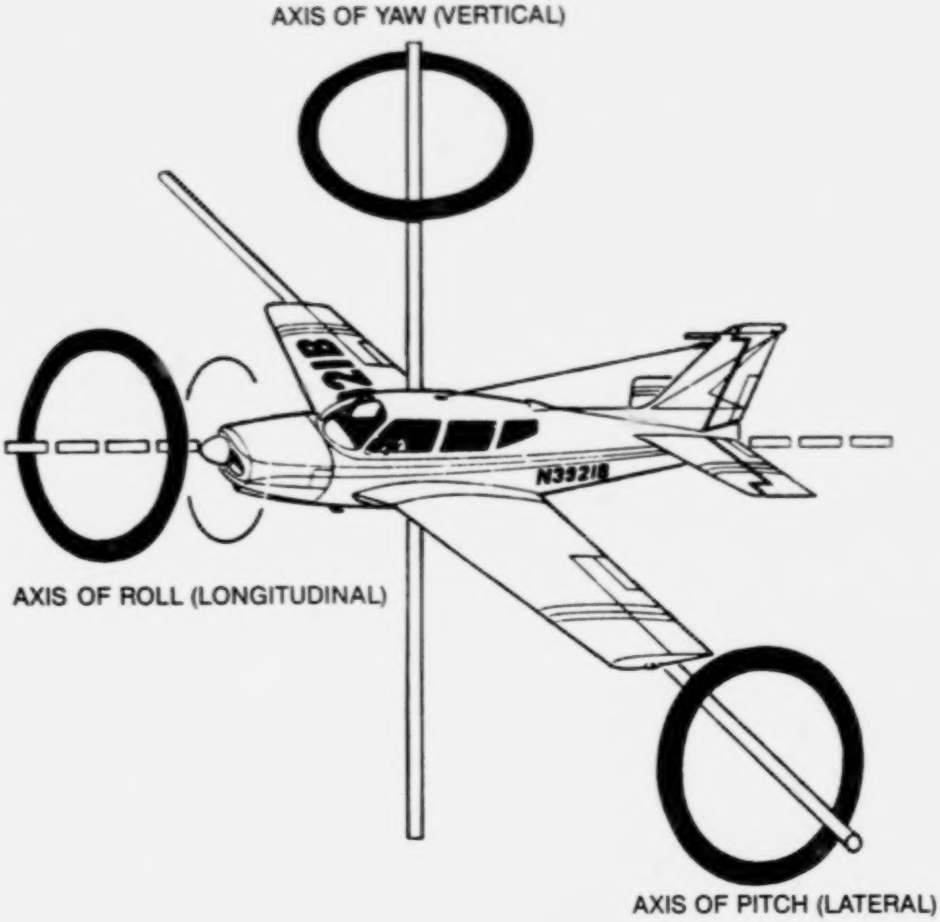
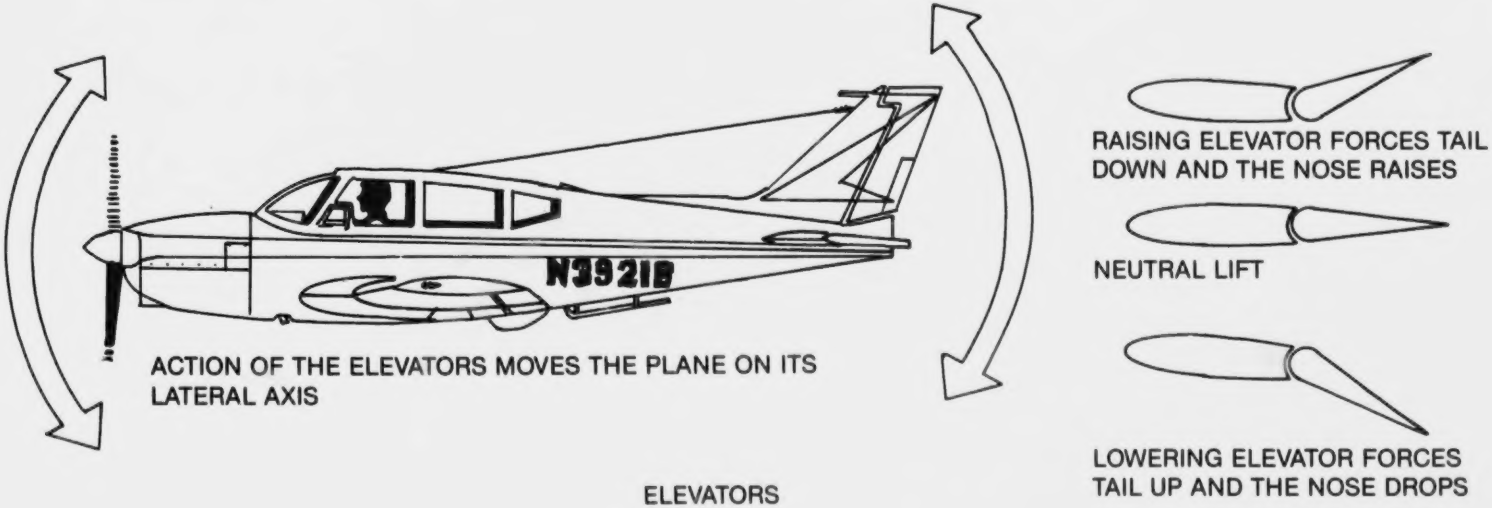
Axes of Rotation


AXIS OF YAW (VERTICAL)
N3921B
AXIS OF ROLL (LONGITUDINAL)
AXIS OF PITCH (LATERAL)

INSTRUCTIONAL SUPPLEMENT #2

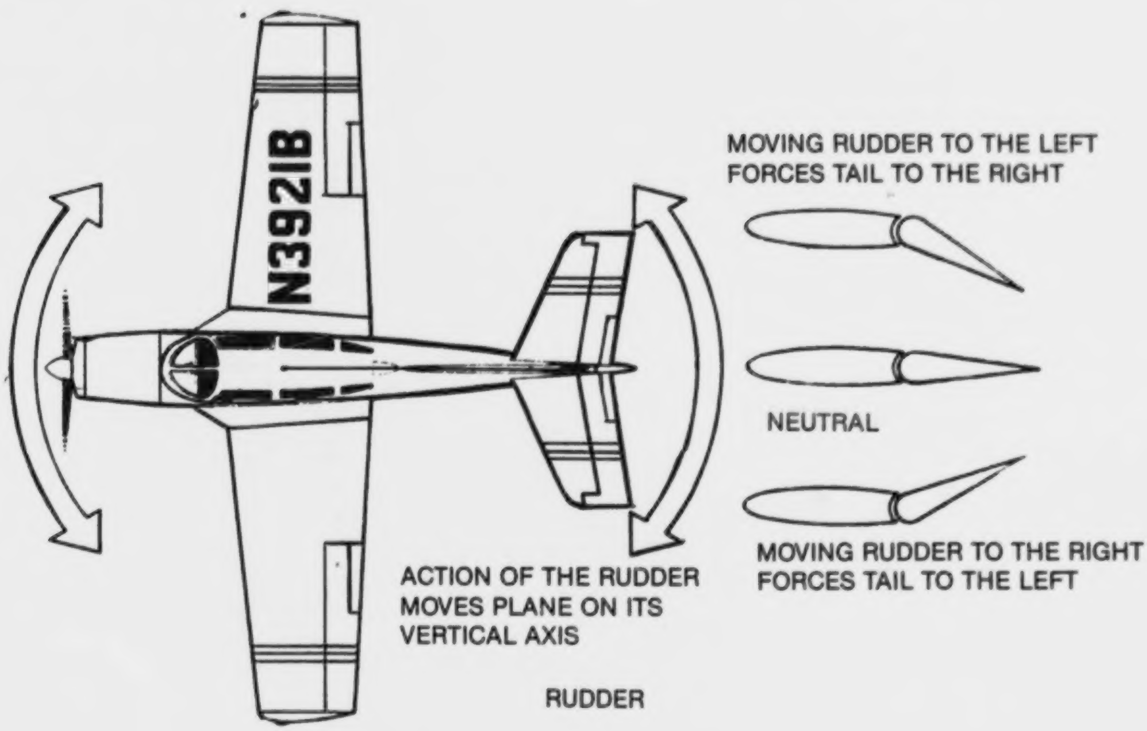
Effect of Elevators


N3921B
ACTION OF THE ELEVATORS MOVES THE PLANE ON ITS LATERAL AXIS
RAISING ELEVATOR FORCES TAIL DOWN AND THE NOSE RAISES
NEUTRAL LIFT
LOWERING ELEVATOR FORCES TAIL UP AND THE NOSE DROPS

ELEVATORS

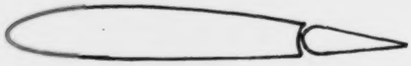
INSTRUCTIONAL SUPPLEMENT #2

Effect of Rudder

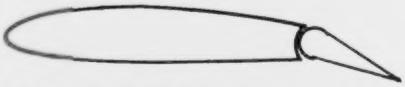

N3921B
MOVING RUDDER TO THE LEFT FORCES TAIL TO THE RIGHT
NEUTRAL
MOVING RUDDER TO THE RIGHT FORCES TAIL TO THE LEFT
ACTION OF THE RUDDER MOVES PLANE ON ITS VERTICAL AXIS
RUDDER

INSTRUCTIONAL SUPPLEMENT #2

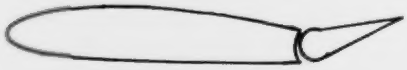
Effect of Ailerons



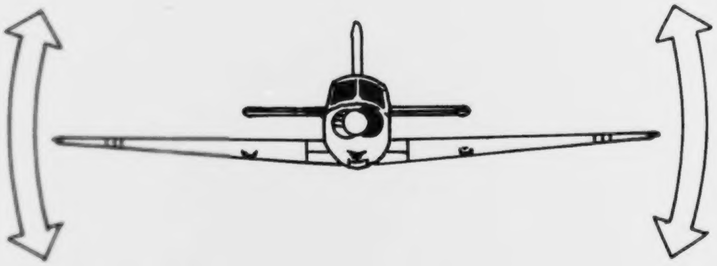
NORMAL LIFT



LOWERING AILERON INCREASES LIFT AND RAISES WING



RAISING AILERON DECREASES LIFT AND LOWERS WING



ACTION OF AILERONS MOVES THE PLANE ON ITS LONGITUDINAL AXIS

AILERONS

TECHNICAL INFORMATION SUPPLEMENT #1 - Terms and Definitions

A. Aviation - Term applied to all phases of the manufacture and operation of aircraft

B. Airplane - Engine-driven, fixed-wing aircraft heavier than air, that is supported in flight by the dynamic reaction of the air against its wings

C. Multiengine - Having more than one engine

D. Seaplane - Airplane that operates from water

E. Monoplane - Airplane having one set of wings

F. Wings - Part of the airplane shaped like an airfoil and designed in such a way to provide lift when air flows over them

G. Landing gear - Understructure of an airplane which supports the airplane on land or water

Examples: Wheels, skis, pontoons

(NOTE: Retractable gear folds up into the airplane in flight. Gear that does not retract is called "fixed.")

H. Conventional landing gear - Type of landing gear with wheels attached to a strut assembly located forward of the center of gravity and with either a skid or wheel assembly at the tail

I. Tricycle landing gear - Landing gear of an aircraft in which the main wheels are behind the center of gravity and the nose is supported with an auxiliary nose wheel

J. Propeller - Device for propelling an aircraft that has blades on an engine-driven shaft and that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation

(NOTE: A propeller includes control components normally supplied by its manufacturer, but does not include main and auxiliary rotors or rotating airfoils of engines.)

K. Aircraft engine - Engine that is used or intended to be used for propelling aircraft

(NOTE: An aircraft engine includes turbosuperchargers, appurtenances, and accessories necessary for its functioning, but does not include propellers.)

L. Cockpit - Portion of the inside of the airplane occupied by the person(s) operating the airplane, and containing the instruments and controls

M. Instruments - Dials or gauges by which information about the flight, airplane, or engine is relayed to the pilot

(NOTE: When the pilot flies the airplane solely by reference to the gauges, he is said to be flying "on instruments.")

N. Fuselage - Streamlined body of an airplane to which the wings and tail are fastened

O. Empennage - Rear portion, or the tail section, of the airplane

P. Tail - Part of the airplane to which the rudder and elevators are attached

(NOTE: The tail has vertical and horizontal stabilizers.)

Q. Vertical stabilizer - Portion of empennage which provides stability for the airplane around the vertical axis

R. Horizontal stabilizer - Portion of empennage which provides stability for the airplane around the lateral axis

S. Elevators - Control surfaces hinged to the horizontal stabilizer which controls the pitch of the airplane, or the position of the nose of the airplane relative to the horizon

T. Rudder - Control surface hinged to the back of the vertical stabilizer

U. Pedals/rudder pedals - Foot controls in the cockpit which can be used by the pilot to control rudders, brakes, and nose gear steering

V. Aileron - Control surface hinged at the back of the wings which helps to bank the airplane by deflecting up or down

W. Flaps - Hinged or pivoted airfoils forming part of the trailing edge/leading edge of the wing and used to increase lift at reduced airspeeds

X. Airfoil - Any surface designed to obtain a useful reaction, or lift, from the air through which it moves

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TECHNICAL INFORMATION SUPPLEMENT #2 - Similarities of Aircraft and Birds

(NOTE: Throughout recorded history, mankind watched birds in flight and yearned to duplicate their actions. As flight became possible, certain bird-like features were included in the aircraft's design.)

A. Wide wings provide lift to support the weight of the bird or aircraft. Aircraft may be constructed with their wings above, below, or at the center of the aircraft body

B. A bird obtains lift from downward movements of its wings; and aircraft use thrust from a propeller or jet engine to produce the forward motion needed for lift

C. Control of both the bird and aircraft is achieved by movable portions of the tail and wingtips. While the bird uses feathers for this purpose, the aircraft is fitted with control surfaces

D. The bird's hollow skeleton provides great strength with minimal weight; an aircraft's light structure serves a similar function

E. A bird folds its legs tightly against its body to reduce wind resistance. Many aircraft retract their wheels to lessen drag

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TECHNICAL INFORMATION SUPPLEMENT #3 - Four Forces of Flight

Air is a fluid. Through its resistance, the fluid air provides support for the wing of a bird -- or an airplane -- that is moving through it. Just as you support and propel yourself in swimming by pushing against the water, the bird (or airplane) supports and propels itself aloft by pushing against the air.

The bird pushes against the air by moving its wings. A downward push compresses the air below the wings -- and produces **lift** to stay aloft. A rearward push compresses the air behind the wings -- and produces **thrust** to propel the bird forward. It's a lot like the breaststroke in swimming.

The airplane uses exactly the same ideas to stay up and move forward, but in a different way. Man found it impossible to duplicate, with his machines, the combined downward and rearward motions of the bird's wings. Some of his most comical failures in attempting to fly came in the construction of "flapping wing" aircraft (ornithopters) -- none of which ever got off the ground.

Learning from these failures, man separated the tasks of staying up (or maintaining **lift**) and moving forward (or gaining **thrust**) in his airplane designs.

To the wing, man gave the job of keeping the airplane up. He saw that the bird's wing was curved upward, so that more air passes over its upper rather than its lower surface. He copied this design of nature -- and in spite of their primitive powerplant, the Wright brothers made flying a reality. **Lift** had overcome **gravity**, the universal force that kept man earthbound.

The clue to efficient wing design came from Jean Marie Lebris, a French sea captain and inventor of the glider, or motorless airplane. Lebris had killed an albatross. He took a wing of the bird and, in his words "...exposed it to the breeze; and lo! in spite of me it drew forward into the wind; and tended to rise."

To the propeller and engine (and later, to the jet powerplant), man gave the job of creating **thrust** to move the wing -- and the airplane -- forward. He made it powerful enough to overcome the **drag** or resistance to the forward motion of the entire structure. Then he had a heavier-than-air machine that could join the birds in their own element.

The four forces which govern all flight -- **lift** against **gravity**, and **thrust** against **drag** -- thus were under man's command. But to make the airplane practical -- and beat the birds at their own game -- he needed ways to adapt his fixed wing to the varying needs of takeoff, cruising flight, and landing. He found them.

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TECHNICAL INFORMATION SUPPLEMENT #3

Watch a bird land on a limb. Watch his wings. The front edge of the wing will be very high and the rear edge very low. The bird is simply increasing the angle at which his wings meet the air (the "**angle of attack**" as fliers call it) to help him slow to landing speed.

The airplane pilot gets this same result by reducing his engine and propeller speed, and tilting his airplane upward by raising the elevators. This slows the forward motion and gradually reduces the **lift** of the wings, letting the airplane sink earthward under full control. Very near the ground, the pilot "flares out" to lose all lift, easing the airplane to a soft, smooth landing.

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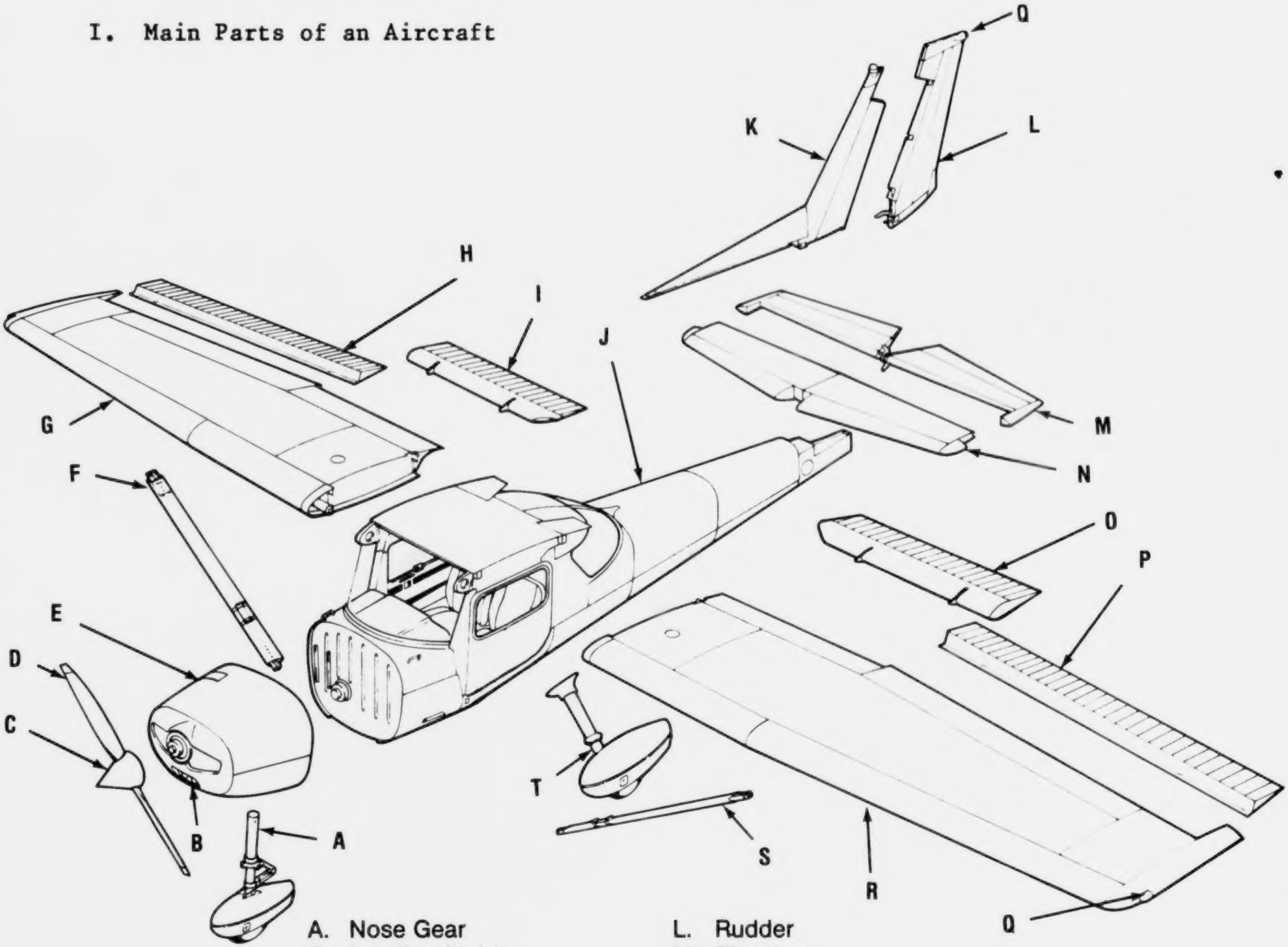
TECHNICAL INFORMATION SUPPLEMENT #4--Parts and Structure of an Aircraft

I. Main Parts of an Aircraft



A. Nose Gear
B. Landing Lights
C. Spinner
D. Propeller
E. Engine Cowl
F. Right Wing Strut
G. Right Wing
H. Right Aileron
I. Right Flap
J. Fuselage
K. Vertical Stabilizer
L. Rudder
M. Elevator
N. Horizontal Stabilizer
O. Left Flap
P. Left Aileron
Q. Position Lights
R. Left Wing
S. Left Wing Strut
T. Main Landing Gear

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TECHNICAL INFORMATION SUPPLEMENT #4

II. Basic Components of the Aircraft Structure

A. All aircraft have certain features in common, but are equipped to do different jobs and are used by the pilot in different ways

1. The body of an aircraft is called the fuselage; it provides space for seats, cargo areas, or baggage compartments

2. In addition to producing lift, the wings will normally contain fuel tanks, and will also provide attachment points for control surfaces and, in some cases, engines or wheels

3. The engine, or powerplant, generates thrust for the aircraft's forward motion, and will usually be located:

   a. At the front of the fuselage (single-engine aircraft)
   b. On the wings (twin-engine propeller aircraft)
   c. On the rear fuselage sides (twin-engine jet aircraft)

4. An aircraft's wheels are called the landing gear. They may be retracted into the fuselage or wings to lessen drag

5. The tail assembly, or empennage, provides stability and control much like the feathers of an arrow

6. An aircraft's control surfaces include:

   a. Ailerons, movable portions of each wingtip's trailing edge
   b. Rudder, a control surface at the rear of the vertical stabilizer
   c. Elevator, a control surface at the rear of the horizontal stabilizer
   d. Trim tabs on one or more of the primary control surfaces (ailerons, rudder or elevator), which may be adjusted to relieve control forces
   e. Flaps, sections of the wing's trailing edge/leading edge can be lowered to increase lift and drag

7. Because most aircraft are equipped with radios, various types of antennas will usually be mounted above and below the fuselage or on the vertical stabilizer

8. Approved navigation lights (a green light on right wing, a red light on the left wing, and a white light on the tail) help other pilots determine the aircraft's direction of travel at night. These lights are supplemented by red flashing beacons or white strobe lights for greater visibility

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B. Although the cockpit of a general aviation aircraft will be much like that of an airliner, different equipment may be installed to perform specific tasks. The following features are common to most aircraft.

1. Flight control instruments are located on the left side of the instrument panel, directly in front of the pilot
2. Radios are placed in the center of the instrument panel
3. Engine instruments may be found beside the radios and on the lower portion of the instrument panel
4. An additional control wheel and a set of rudder pedals on the right side of the cockpit will usually be installed for a copilot or flight instructor's use
5. The centrally-located engine controls, trim controls, and microphone are accessible from either seat

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TECHNICAL INFORMATION SUPPLEMENT #5 - How an Aircraft is Controlled

I. Functions of an aircraft's controls and how they are operated by the pilot

A. Ailerons

1. As the control wheel is turned to the left, the left aileron is raised and the right aileron is lowered, causing the aircraft to bank to the left

2. If the control wheel is turned to the right, the right aileron will be raised and the left aileron will be lowered, creating a bank to the right

B. Rudder

1. Depressing the right rudder pedal moves the rudder to the right, causing the tail to move to the left and the nose of the aircraft to the right

2. Depressing the left rudder pedal displaces the rudder to the left, moving the aircraft's tail to the right and the nose to the left

C. Elevators

1. Forward movement of the control wheel lowers the elevators, to cause the tail of the aircraft to rise and the nose to go down

2. Rearward movement of the control wheel raises the elevator, bringing the tail down and the nose up

D. Ground steering

1. Movement of the rudder pedal turns the nosewheel left or right to steer the aircraft on the ground

2. The nosewheel does not steer in flight

E. Brakes--Depressing the top section of each rudder pedal activates individual wheel brakes, used separately for maneuvering or together for stopping

Adapted with permission of Cessna Aircraft Company, P.O. Box 1521, Wichita, Kansas.

F. Flaps

1. Activated by hydraulic power, electric motors, or with a manual lever, both wing flaps are lowered before landing to increase the wing's lift and drag

2. During normal cruising flight the flaps are retracted

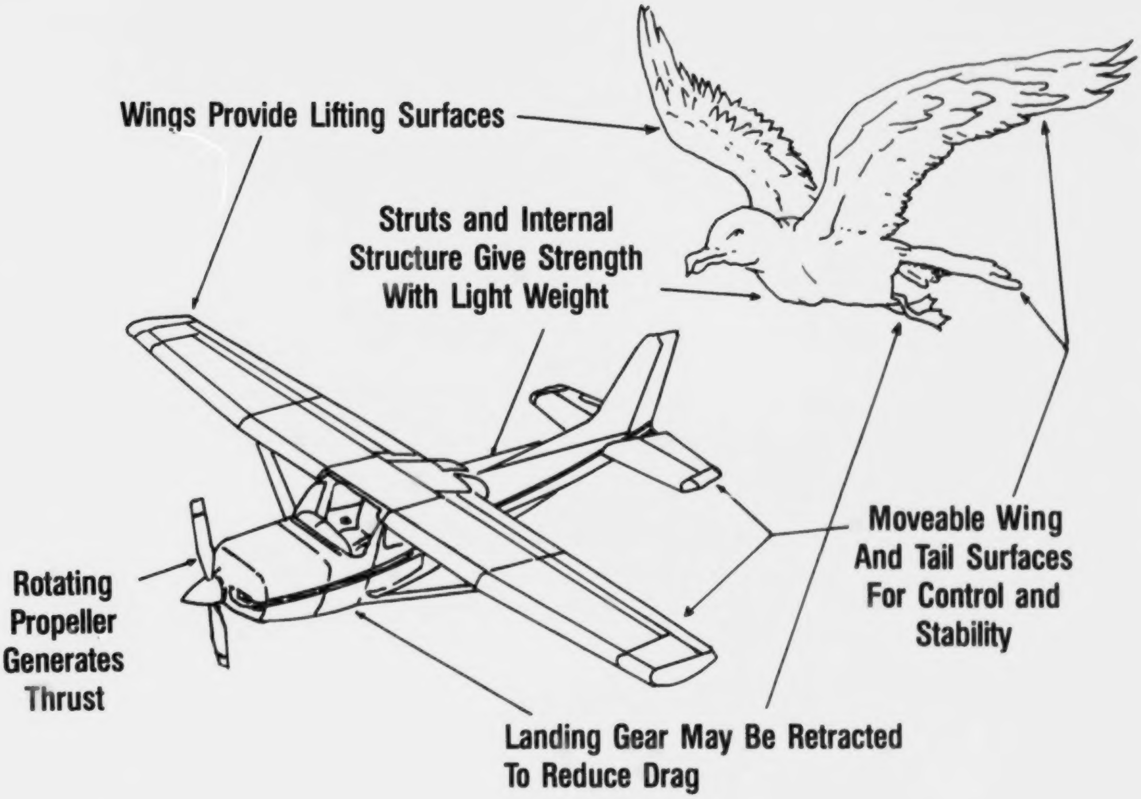
G. Power control--Forward movement of the throttle increases the engine's power output for takeoff and climb, while rearward throttle movement decreases engine power to descend for a landing

H. Mixture control--The primary carburetor control for adjusting fuel/air mixture

(NOTE: The control handle is moved full rearward for idle-cutoff.)

Adapted with permission of Cessna Aircraft Company, P.O. Box 1521, Wichita, Kansas.

How Birds and Aircraft Fly


Wings Provide Lifting Surfaces
Struts and Internal Structure Give Strength With Light Weight
Rotating Propeller Generates Thrust
Moveable Wing And Tail Surfaces For Control and Stability
Landing Gear May Be Retracted To Reduce Drag

TM #1

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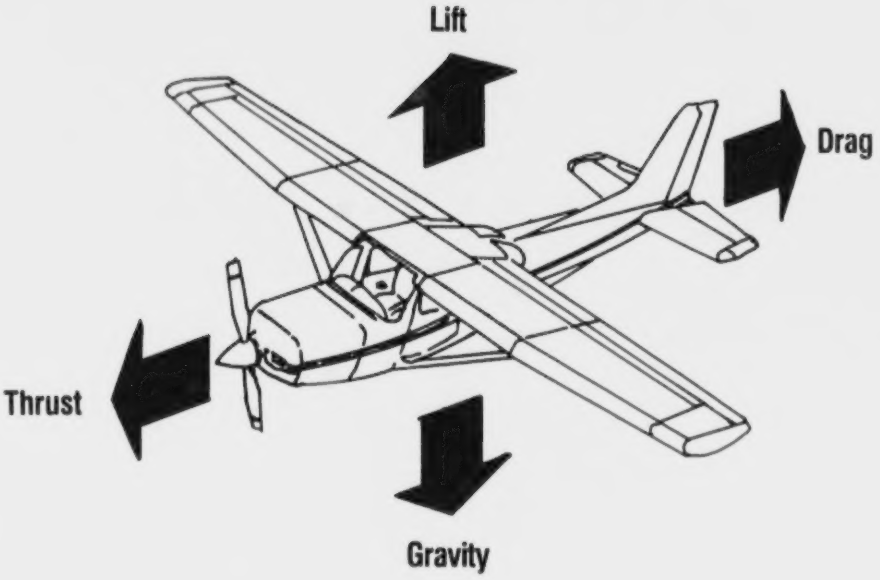
The Four Forces of Flight



In Constant Speed Flight All Four Forces Are In Balance

A. Gravity — Universal Force Which Attracts all Objects to the Earth
B. Lift — Upward Reaction to the Wing's Passage Through the Air
C. Drag — Resistance of the Air to the Forward Motion of the Aircraft
D. Thrust — Aircraft's Propeller Pushing a Large Quantity of Air Rearward

TM #2

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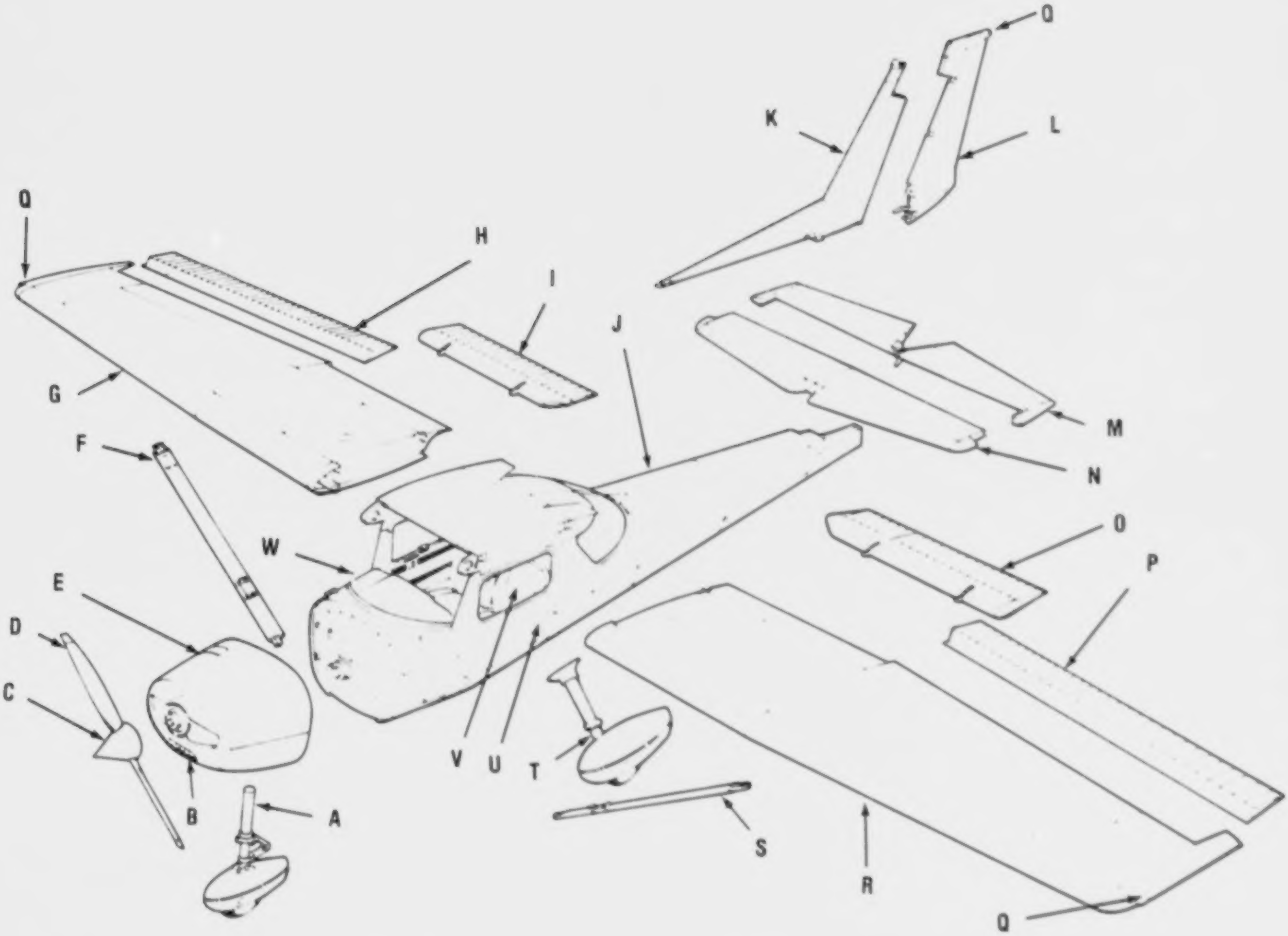
The Main Parts of an Airplane



A. Nose Gear
B. Landing Lights
C. Spinner
D. Propeller
E. Engine Cowl
F. Right Wing Strut
G. Right Wing
H. Right Aileron
I. Right Flap
J. Fuselage
K. Vertical Stabilizer
L. Rudder
M. Elevator
N. Horizontal Stabilizer
O. Left Flap
P. Left Aileron
Q. Position Lights
R. Left Wing
S. Left Wing Strut
T. Main Landing Gear
U. Door
V. Seat
W. Windshield

TM #3

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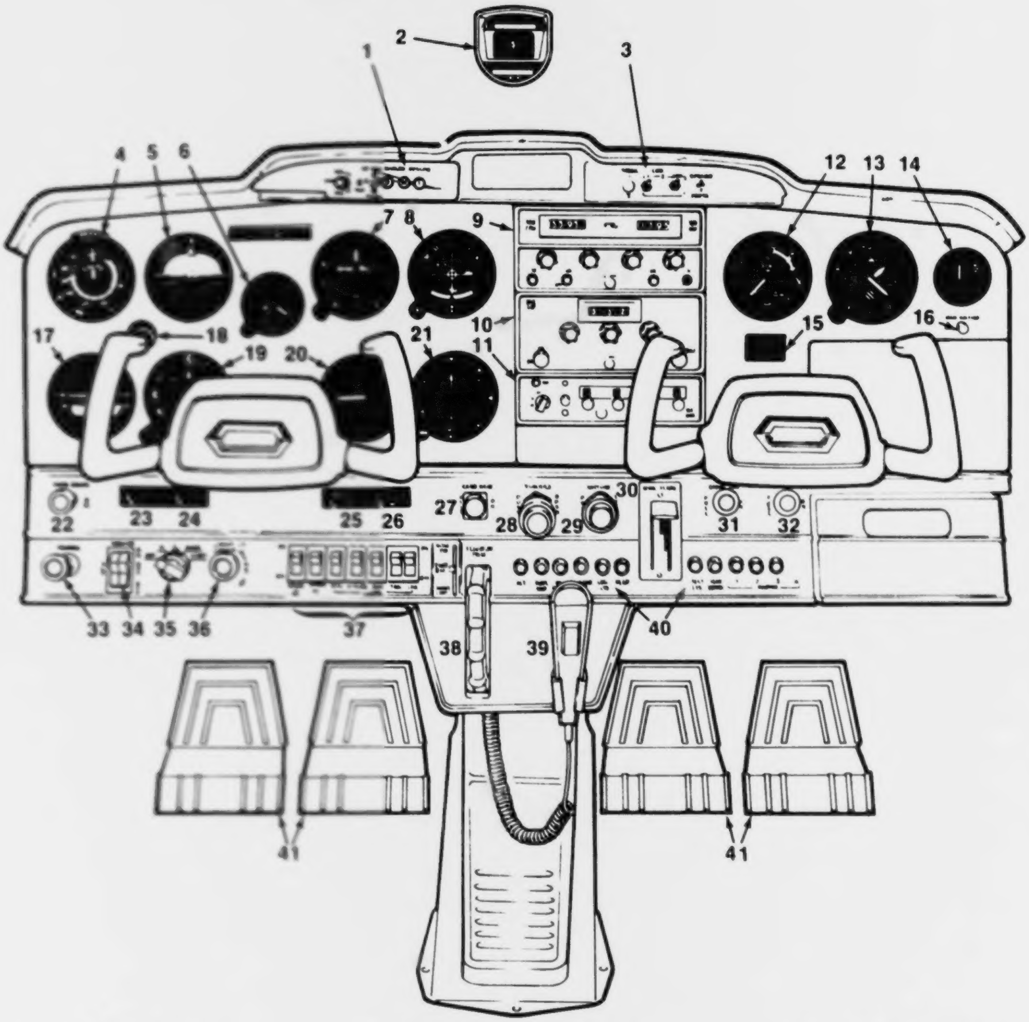
INSTRUMENT PANEL



1. Marker Beacon Lights
2. Magnetic Compass
3. Audio Switching Panel
4. Airspeed Indicator
5. Altitude Indicator
6. Clock
7. Encoding Altimeter (Electric)
8. Omni Bearing Selector
9. NAV/COM (Radio)
10. Automatic Direction Finder (Radio)
11. Transponder
12. Tachometer
13. Altimeter (Barometric)
14. Battery/Alternator Indicator
15. Hour Meter
16. High Voltage Warning Light
17. Turn-and-Bank Indicator
18. Suction Indicator
19. Heading Indicator
20. Vertical Velocity Indicator
21. ADF Indicator
22. Parking Brakes
23. Fuel Gauge (Left Tank)
24. Fuel Gauge (Right Tank)
25. Oil Temperature Gauge
26. Oil Pressure Gauge
27. Carburetor Heat Control
28. Throttle Control
29. Fuel Air Mixture Control
30. Wing Flaps Control
31. Cabin Air Control
32. Cabin Heat Control
33. Engine Primer
34. Master Switch
35. Ignition Switch
36. Panel Light Control
37. Interior & Exterior Lights
38. Trim Tab Control
39. Microphone
40. Circuit Breakers
41. Rudder/Brake Pedals

TM #4

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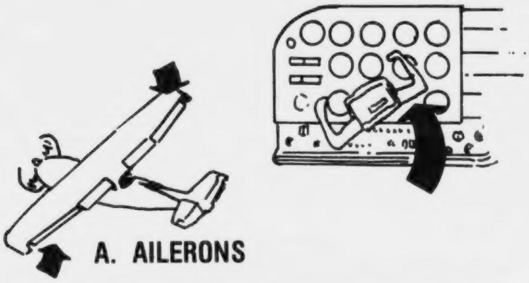
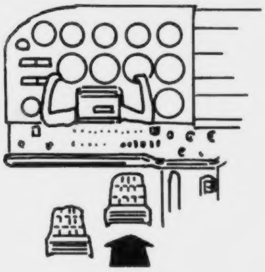
HOW AN AIRCRAFT IS CONTROLLED



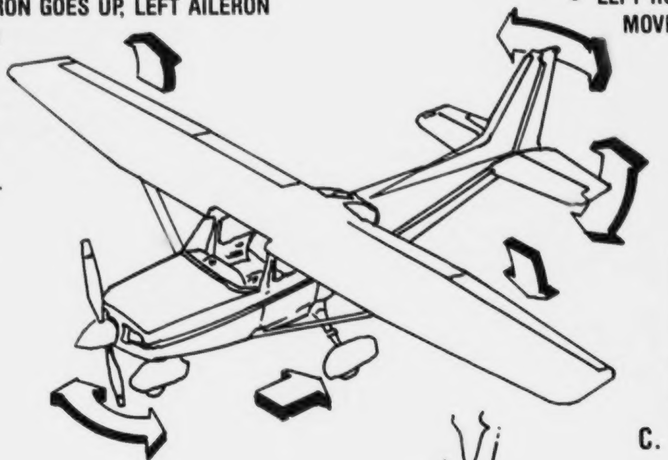
A. AILERONS

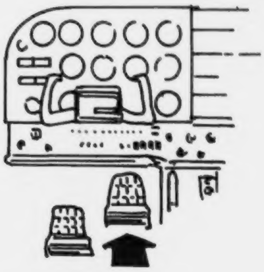
- AS CONTROL WHEEL IS TURNED LEFT, LEFT AILERON GOES UP, RIGHT AILERON GOES DOWN
- AS CONTROL WHEEL IS TURNED RIGHT, RIGHT AILERON GOES UP, LEFT AILERON GOES DOWN



B. RUDDER

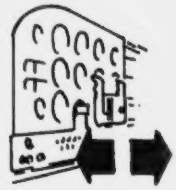
- RIGHT RUDDER PEDAL MOVES RUDDER TO RIGHT
- LEFT RUDDER PEDAL MOVES RUDDER TO LEFT





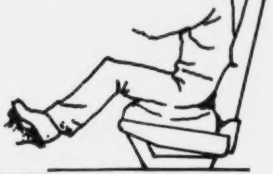
D. NOSE WHEEL

- RIGHT RUDDER PEDAL TURNS NOSEWHEEL RIGHT
- LEFT RUDDER PEDAL TURNS NOSEWHEEL LEFT



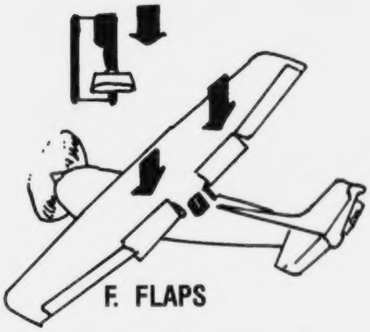
C. ELEVATOR

- FORWARD CONTROL WHEEL MOVEMENT LOWERS ELEVATOR
- REARWARD CONTROL WHEEL MOVEMENT RAISES ELEVATOR



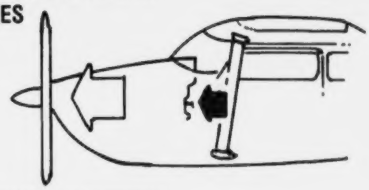
E. BRAKES

- DEPRESSING TOP OF RUDDER PEDAL ACTIVATES THE WHEEL BRAKE
- DEPRESSING BOTH PEDALS ACTIVATES BOTH WHEEL BRAKES



F. FLAPS

- AS FLAP LEVER IS MOVED DOWNWARD WING FLAPS ARE LOWERED



G. POWER CONTROL

- FORWARD MOVEMENT OF THROTTLE INCREASES ENGINE POWER
- REARWARD MOVEMENT OF THROTTLE DECREASES ENGINE POWER

TM #5

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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY BASIC COMPONENTS OF AIRCRAFT
G102-A

THEORY TEST

1. Match terms related to basic components of aircraft structures to their correct definitions. Write the correct numbers in the blanks.

____a. Part of the airplane to which the rudder and elevators are attached

____b. Portion of empennage which provides stability for the airplane around the vertical axis

____c. Engine that is used or intended to be used for propelling aircraft

____d. Airplane having one set of wings

____e. Control surface hinged to the back of the vertical stabilizer

____f. Airplane that operates from water

____g. Dials or gauges by which information about the flight, airplane, or engine is relayed to the pilot

____h. Control surface hinged at the back of the wings which helps to bank the airplane by deflecting up or down

____i. Engine-driven, fixed-wing aircraft heavier than air, that is supported in flight by the dynamic reaction of the air against its wings

____j. Control surfaces hinged to the horizontal stabilizer which controls the pitch of the airplane, or the position of the nose of the airplane relative to the horizon

____k. Understructure of an airplane which supports the airplane on land or water

____l. Landing gear of an aircraft in which the main wheels are behind the center of gravity and the nose is supported with an auxiliary nose wheel

1. Seaplane
2. Instruments
3. Tail
4. Rudder
5. Aileron
6. Landing gear
7. Monoplane
8. Airplane
9. Aircraft engine
10. Elevators
11. Vertical stabilizer
12. Tricycle landing gear

THEORY TEST

____ m. Part of the airplane shaped like an airfoil and designed in such a way to provide lift when air flows over them

____ n. Device for propelling an aircraft that has blades on an engine-driven shaft and that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation

____ o. Term applied to all phases of the manufacture and operation of aircraft

____ p. Hinged or pivoted airfoils forming part of the trailing edge/leading edge of the wing and used to increase lift at reduced airspeeds

____ q. Foot controls in the cockpit which can be used by the pilot to control rudders, brakes, and nose gear steering

____ r. Portion of the inside of the airplane occupied by the person(s) operating the airplane, and containing the instruments and controls

____ s. Portion of empennage which provides stability for the airplane around the lateral axis

____ t. Having more than one engine

____ u. Streamlined body of an airplane to which the wings and tail are fastened

____ v. Any surface designed to obtain a useful reaction, or lift, from the air through which it moves

____ w. Rear portion, or the tail section, of an airplane

____ x. Type of landing gear with wheels attached to a strut assembly located forward of the center of gravity and with either a skid or wheel assembly at the tail

13. Multiengine
14. Aviation
15. Wings
16. Flaps
17. Pedals/rudder pedals
18. Propeller
19. Fuselage
20. Cockpit
21. Horizontal stabilizer
22. Conventional landing gear
23. Empennage
24. Airfoil

2. Complete statements related to the ways in which modern aircraft are similar to birds. Write the correct answers in the blanks.

   a. Wings provide __________ to support the weight of the bird or aircraft.

   b. An aircraft uses _________________ from a propeller or jet engine to provide the forward motion needed for lift whereas the bird uses the downward movements of its wings.

   c. Control of both the bird and aircraft is achieved by _________________ portions of the tail and wingtips.

   d. The bird's hollow skeleton provides great _______________ with minimal _____________________; an aircraft's light structure serves a similar function.

   e. A bird folds its legs tightly against its body to reduce wind resistance, many aircraft _______________ their wheels to lessen drag.

3. Define the four forces of flight.

   a. Thrust--____

      ____

   b. Lift--____

      ____

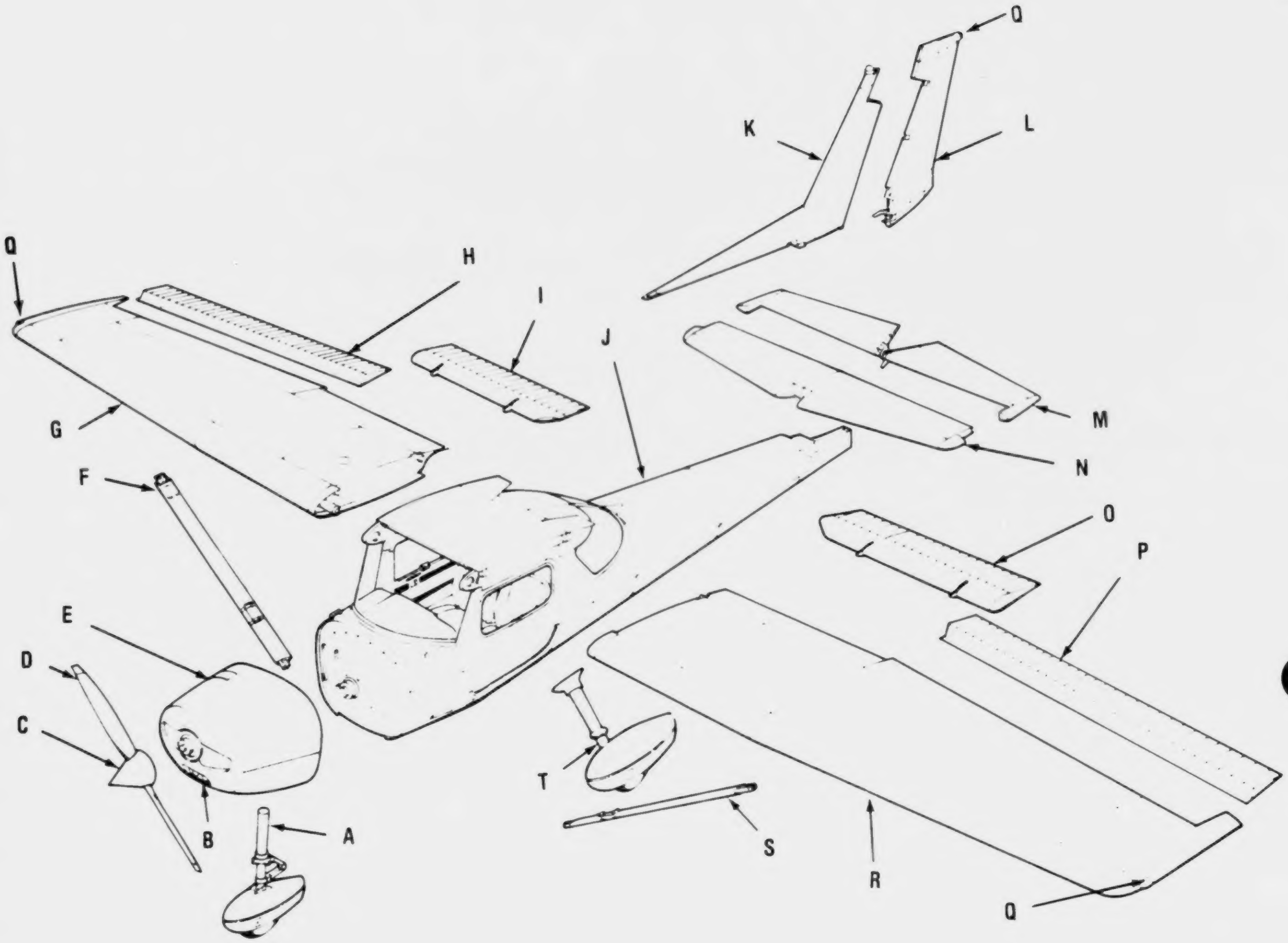
   c. Drag--____

      ____

   d. Gravity--____

      ____

4. Identify the basic components of the aircraft structure below. Write the correct names in the blanks.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c. ____________________

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i. ____________________

j. ____________________

k. ____________________

l. ____________________

m. ____________________

n. ____________________

o. ____________________

p. ____________________

q. ____________________

r. ____________________

s. ____________________

t. ____________________

THEORY TEST

5. Select true statements related to the basic components of an aircraft structure. Circle the number before each correct answer.

   a. The body of an aircraft is called the:

      1. Empennage

      2. Dihedral pod

      3. Fuselage

      4. Decalage

   b. On a single engine aircraft the engine is usually located

      1. At the front of the fuselage

      2. At the rear of the fuselage

      3. In the middle of the fuselage

      4. On the wing

   c. The empennage provides

      1. Fuel to the engine

      2. Stability and control

      3. Power and thrust

      4. A platform for radio transmitters

   d. What is located on the wingtips and tail to help other pilots determine the aircraft's direction of travel at night?

      1. Electronic sound transponders which code a signal to passing aircraft

      2. A red light on the right wing, green light on the left wing and an amber light on the tail

      3. Reflective mirrors

      4. A green light on the right wing, a red light on the left wing, and a white light on the tail

6. Select true statements related to the function of aircraft controls and how they are operated by the pilot. Circle the number before each correct answer.

   a. Select how the ailerons and aircraft are positioned when the control is turned to the left.

      1. The left aileron is raised and the right aileron is lowered, the airplane is in a right bank

      2. The left aileron is raised and the right aileron is lowered, the aircraft is in a left bank

      3. The left aileron is lowered and the right aileron is raised, the aircraft is in a left bank

      4. The left aileron is lowered and the right aileron is raised, the aircraft is in a right bank

   b. Depressing the right rudder pedal causes the airplane's rudder and nose to move in which direction?

      1. Rudder left, nose right

      2. Rudder left, nose left

      3. Rudder right, nose left

      4. Rudder right, nose right

   c. Forward movement of the control wheel causes what change in the elevator and nose position?

      1. Elevator up, nose down

      2. Elevator down, nose down

      3. Elevator up, nose up

      4. Elevator down, nose up

   d. Forward movement of the engine's power control lever causes what change in engine operation?

      1. Increases the engine's power output

      2. Increases the richness of the fuel/air mixture but does not increase power

      3. Decreases the engine's power output

      4. Decreases the richness of the fuel/air mixture, while increasing engine power

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY BASIC COMPONENTS OF AIRCRAFT
G102-A

ANSWERS TO THEORY TEST

1. a. 3
   b. 11
   c. 9
   d. 7
   e. 4
   f. 1
   g. 2
   h. 5
   i. 8
   j. 10
   k. 6
   l. 12
   m. 15
   n. 18
   o. 14
   p. 16
   q. 17
   r. 20
   s. 21
   t. 13
   u. 19
   v. 24
   w. 23
   x. 22

2. a. Lift
   b. Thrust
   c. Movable
   d. Strength, weight
   e. Retract

3. a. Thrust - A reaction to the aircraft's propeller pushing a large quantity of air rearward
   b. Lift - Upward reaction to a wing's passage through the air
   c. Drag - The resistance of the air to the forward motion of the aircraft
   d. Gravity - The universal force which attracts all objects to the earth

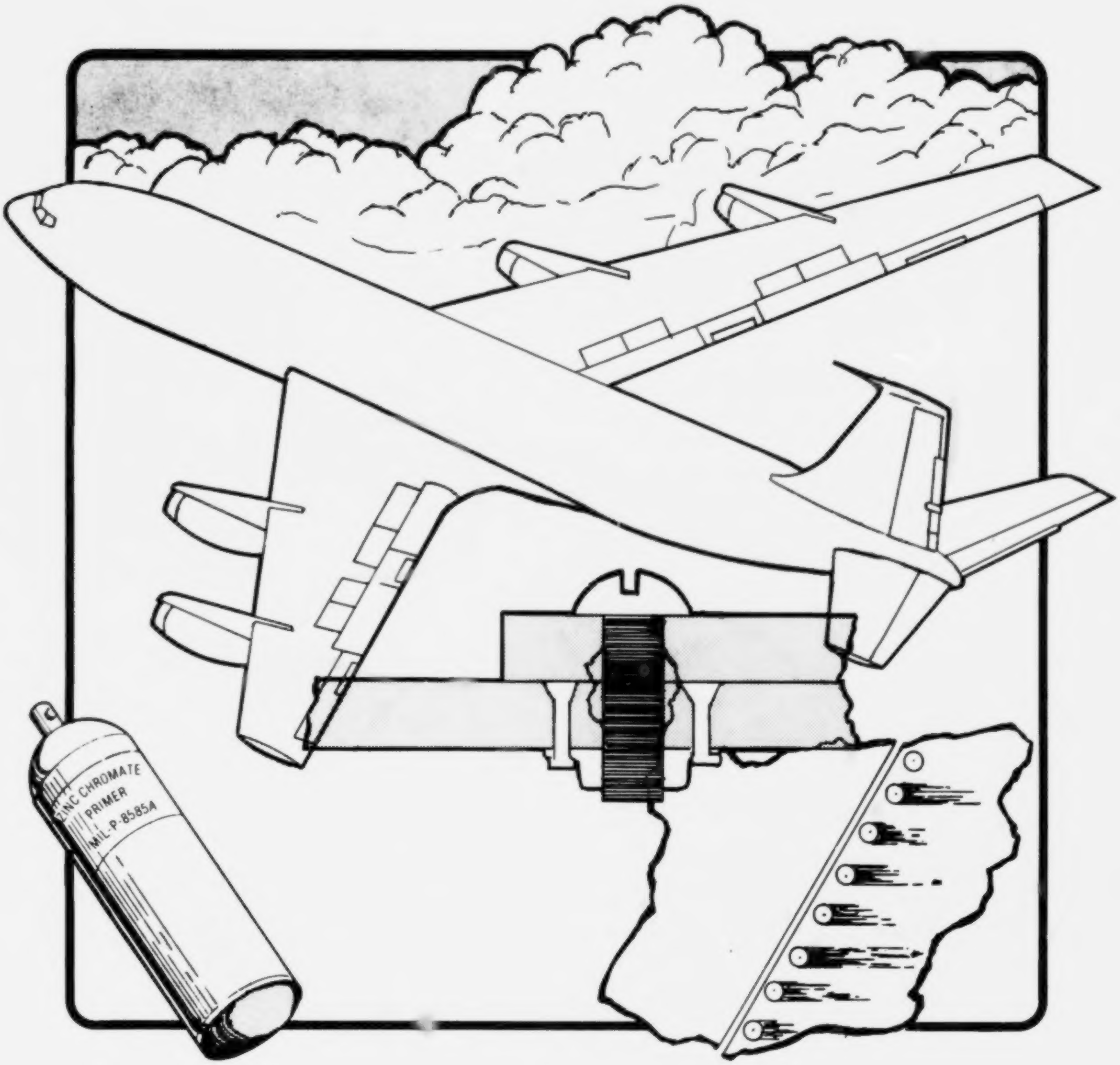
4. a. Nose gear
   b. Landing lights
   c. Spinner
   d. Propeller
   e. Engine cowl
   f. Right wing strut
   g. Right wing
   h. Right aileron
   i. Right flap
   j. Fuselage
   k. Vertical stabilizer
   l. Rudder
   m. Elevator
   n. Horizontal stabilizer
   o. Left flap
   p. Left aileron
   q. Position lights
   r. Left wing
   s. Left wing strut
   t. Main landing gear

5. a. 3
   b. 1
   c. 2
   d. 4

6. a. 2
   b. 4
   c. 2
   d. 1

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

MODULE CONTENTS

A. Introduction and Module Objective

B. Specific Objectives

C. Instructor's Module Implementation Guide

D. Technical Information Supplements

1. Technical Information Supplement #1 - Terms and Definitions

2. Technical Information Supplement #2 - Use of Aircraft Chemicals

3. Technical Information Supplement #3 - Safety Precautions

E. Transparency Masters

1. TM #1 - Electrochemical Series for Metals

2. TM #2 - Electrolytic Action in a Battery

3. TM #3 - Electrolytics of Corrosion

4. TM #4 - Types of Corrosion

5. TM #5 - Types of Corrosion (Continued)

6. TM #6 - Types of Corrosion (Continued)

7. TM #7 - Types of Corrosion (Continued)

8. TM #8 - Dissimilar Metals

9. TM #9 - Corrosive Agents

10. TM #10 - Microbial Growth

11. TM #11 - Detection Methods for Corrosion

12. TM #12 - Water Break Test

F. Workbook Supplements

1. Workbook Supplement #1 - Use Technical Terms Related to Aircraft Cleaning and Corrosion Control

2. Workbook Supplement #2 - Interpret Technical Information for Aircraft Corrosion Control

MODULE CONTENTS

   3. Workbook Supplement #3 - Interpret Chemical Manufacturer's Technical Bulletins

   4. Workbook Supplement #4 - Interpret Manufacturer's Specifications and Recommendations

G. Answers to Workbook Supplements

H. Project Guides

   1. Project Guide #1 - Perform Aircraft Cleaning

   2. Project Guide #2 - Perform Aircraft Corrosion Control

I. Theory Test

J. Answers to Theory Test

K. Practical Test #1 - Perform Aircraft Cleaning and Corrosion Control

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

INTRODUCTION

Corrosion is a machine's - NUMBER ONE ENEMY! In a matter of a few short years, months, or even days corrosion can reduce an incredibly safe and expensive aircraft to a dangerous and worthless vehicle. You, as an aviation maintenance technician, are the front line soldier in the never-ending war on corrosion. Only through your efforts can an aircraft survive its predicted service life. You must first learn about the origins of corrosion; then you must learn where the various types of corrosion attack your aircraft. Finally, you must learn to remove corrosion and prevent its return through protective coatings and corrosion preventive devices. Proper aircraft cleaning and corrosion control will save the aircraft, a great deal of money, and quite possibly a life.

MODULE OBJECTIVE

After completion of this module, you will be able to identify and select cleaning and corrosion preventive products, identify corroded aircraft structures, and perform aircraft cleaning and corrosion control. You will demonstrate this knowledge by completing the procedures outlined in the workbook supplements and project guides. You will further demonstrate this knowledge by scoring a minimum of 85 percent on the module theory test and by meeting airworthiness standards on the module practical test.

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

SPECIFIC OBJECTIVES

After completion of this module, you will be able to

1.	Match terms related to cleaning and corrosion control to their correct definitions. (1)	Technical Supplement #1 Workbook Supplement #1	
2.	State facts related to the electrochemical origins of corrosion. (1)	EA-ITP-G EA-ITP-GW	6:II:25-27 6:9
3.	Identify common types of corrosion found in aircraft structures. (2)	EA-ITP-G EA-ITP-GW	6:II:27-32 6:9-10
4.	Select facts related to the origins of common types of corrosion. (1)	EA-ITP-G EA-ITP-GW	6:II:27-32 6:9-10
5.	List the most common corrosive agents. (1)	EA-ITP=G EA-ITP-GW	6:II:33-34 6:10
6.	Name common nondestructive methods used to detect corrosion. (1)	EA-ITP-G EA-ITP-GW	6:II:34-36 6:11
7.	Match the most corrosion prone areas to the reasons for corrosion in these areas. (1)	EA-ITP-G EA-ITP-GW	6:II:36-40 6:11
8.	Select facts related to cleaning engine parts, metal, fabric, acrylics, and rubber. (1)	EA-ITP-G AC 65-9A AC 65-12A AC 43.13-1A Technical Supplement #2 Workbook Supplement #2-#3	6:II:40-41 page 185-190 page 414 page 95-96
9.	State rules related to safety practices used during aircraft cleaning and corrosion control processes. (1)	Technical Supplement #2	
10.	Perform aircraft cleaning. (3)	Project Guide #1	
11.	Arrange in order the steps for proper paint removal on aircraft structures. (2)	EA-ITP-G	6:II:41
12.	State facts related to the proper mechanical and chemical corrosion removal techniques for aluminum alloys. (1)	EA-ITP-G EA-ITP-GW	6:II:41-42 6:11

SPECIFIC OBJECTIVES

13. Explain the chemical neutralization process for aluminum alloys. (1)	EA-ITP-G6 EA-ITP-GW Technical Supplement #2	6:II:42 6:11
14. List and describe protective coatings used on aluminum alloys. (1)	EA-ITP-G EA-ITP-GW Workbook Supplement #4 Technical Supplement #2	6:II:42-44 6:11
15. Complete statements related to mechanical methods for removing corrosion from ferrous metals. (1)	EA-ITP-G EA-ITP-GW	6:II:44 6:12
16. Complete statements related to surface treatments for ferrous metals. (1)	EA-ITP-G EA-ITP-GW Technical Supplement #2	6:II:44-45 6:12
17. Select processes used for corrosion control of magnesium parts. (1)	EA-ITP-G Technical Supplement #2 AC 65-9A	6:II:45-46 pages 179-180
18. Match corrosion preventive techniques to corrosion prone areas. (1)	EA-ITP-G	6:II:46-47
19. Perform aircraft corrosion control. (3)	Project Guide #2 Technical Supplement #3	

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module

A. Videotape: Aircraft Corrosion Control
EA-CC, Part 1 and 2

B. Booklet: Aircraft Corrosion Control, EA-CC-1.

(NOTE: These references are available from Aviation Maintenance Publishers, Inc., P.O. Box 36, 1000 College View Drive, Riverton, Wyoming 82501.)

II. Implementation Suggestions

(NOTE: Be sure to have students read text material related to specific objectives. Much of this reading can be homework assignments.)

Estimated Teaching Time		Theory	Lab
Objective 1	Explain the terms used in aircraft cleaning and corrosion control. Use Technical Information Supplement #1. Additional terms and definitions may be found in EA-CC-1 Aircraft Corrosion Control. Have students complete Workbook Supplement #1 as a homework assignment.		
Objective 2	Explain the electrochemical origins of corrosion. Use Transparency Masters #1-#3.		
Objective 3	Identify the various types of corrosion. Use Transparency Masters #4-#8. View photographs of corrosion in EA-ITP-G 6:II:28-33.		
Objective 4	Explain the origins of the various types of corrosion.		
Objective 5	Show Transparency Master #9 and explain these corrosive agents. Show Transparency Master #10 to illustrate organic growths. Have students complete EA-ITP-GW 6:9-10.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 6	Show Transparency Master #11 and explain the four most common nondestructive methods used to detect corrosion.		
Objective 7	Identify corrosion prone areas and describe the types of corrosion to be expected in these areas. View photographs in EA-ITP-G 6:II:38-40. Show Part 1 Aircraft Corrosion Control.		
Objective 8	Explain how to choose a chemical for a specific cleaning task. Explain the functions of these chemicals. Use Technical Information Supplement #2 for class research. Have students complete Workbook Supplements #2-#3.		
Objective 9	Discuss the safety rules for general aircraft cleaning and corrosion control processes. Use Technical Information Supplement #3. Emphasize the precautions listed in Technical Information Supplement #2.		
Objective 10	Discuss Project Guide #1 with students. Answer any questions students may have. Have students perform Project Guide #1.		
Objective 11	Explain the proper steps in chronological order for paint removal.		
Objective 12	Explain mechanical and chemical corrosion removal techniques for aluminum alloys.		
Objective 13	Explain the chemical neutralization process for aluminum alloys. Review Technical Information Supplement #2 for related processes.		
Objective 14	Discuss the protective coatings used on aluminum alloys. Be sure to explain the water break test. Use Transparency Master #12. Review related material in Technical Information Supplement #2. Have students complete Workbook Supplement #4.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Thery	Lab
Objective 15	Explain mechanical methods for removing corrosion from ferrous metals.		
Objective 16	Explain how to select surface treatments for ferrous metals. Use Technical Information Supplement #2 for reference.		
Objective 17	Explain how to select the correct process for corrosion control on magnesium parts. Use Technical Information Supplement #2 for reference.		
Objective 18	Discuss corrosion preventive techniques for corrosion prone areas. Have students complete EA-ITP-GW 6:11-12.		
Objective 19	Explain procedures to be used in completing Project Guide #2. Carefully review Technical Information Supplement #3. Have students perform aircraft corrosion control using Project Guide #2. After completion of the module theory test and project guides, have students perform Practical Test #1. Set up for the test as outlined in the instructor's guide.		

TECHNICAL INFORMATION SUPPLEMENT #1 - Terms and Definitions

A. Corrosion - Electrochemical process in which a metal is transformed into powdery chemical compounds which have little mechanical strength

B. Atom - Smallest particle of an element; consists of a positively charged nucleus orbited by one or more negatively charged electrons

C. Molecule - Smallest particle of an element or compound that is capable of retaining the chemical identity of the substance in mass

D. Compound - New entity formed by a union of elements or parts

(NOTE: The parts lose their original identity and assume the characteristics of the compound.)

E. Proton - Positively charged particles in the nucleus of an atom

F. Electron - Most basic particle of negative electricity

(NOTE: It spins around the nucleus of an atom, and under certain conditions can be caused to move from one atom to another. Electrons that travel in this manner are called free electrons.)

G. Electro chemical series table - List of metals arranged in an order that indicates the metal that gives up its electrons most readily

(NOTE: The uppermost metals on the list give up their electrons more easily than the lower metals.)

H. Acid - Chemical substance containing hydrogen, which has a characteristically sour taste, and is prone to react with a base or alkali to form a salt and accept electrons from the alkali

I. Salt - Result of combining an alkali with an acid

(NOTE: Salts are generally porous and powdery in appearance and are the visible evidence of corrosion in a metal.)

J. Alkali - Having the property of reacting with acid to form a salt and giving up electrons to the acid material

K. Nobility - Ranking of metals according to how easily each metal gives up its electons

(NOTE: The most noble metal will not give up its electrons as easily as the less noble metal.)

L. Solution - State in which a base metal and alloying agents are united to form a single, solid metal

M. Anode - Positive plate of an electrochemical combination

EXAMPLE: Battery or electroplating tank

(NOTE: Electrons leaving the anode cause it to be less negative, or positively, charged. When electrons leave an anodic material, the chemical composition of the anode changes from a metal to a salt from reaction with the electrolyte, and the anode is corroded or eaten away.)

N. Cathode - Negative plate of an electrochemical combination

O. Alloy - Substance of different elements, one of which is a metal

P. Electrolyte - Chemical liquid or gas - acid, alkaline, or salt - which will conduct electrical current by releasing ions to unite with ions on the electrodes

Q. Potential difference electrode (pd) - Voltage existing between two terminals or two points of differing potential

R. Ferrous metal - Iron or any alloy containing iron

S. Non-ferrous metal - Metal that contains no iron

T. Cell - Device that generates electricity

U. Faying surface - Overlapping area of adjoining surfaces

V. Tensile stress (tension) - Stress produced in a body by forces acting along the same line but in opposite directions

W. Interference fit - Fit between two parts in which the part being put into a hole is larger than the hole itself

(NOTE: In order to fit them together, the hole is expanded by heating, and the part is shrunk by chilling. When the two parts reach the same temperature they will not separate. The area around the hole is subject to tensile stress and thus vulnerable to stress corrosion.)

X. Polyurethane enamel - Two-component, chemically cured enamel finishing system, noted for its hard, flexible, high-gloss finish

Y. Precipitate - To condense out of, or to separate from a mixture

Z. Amalgamate - To form an alloy with mercury

AA. Microbes - Microscopic forms of animal life

(NOTE: Microbes exist in water and feed on hydrocarbon aircraft fuel. They form a water-entrapping scum on the bottom of jet aircraft fuel tanks.)

BB. Entrained water - Water held in suspension in aircraft fuel

(NOTE: It is in such tiny droplets that it passes through filters and will do no damage until the temperature of the fuel drops to the point that these tiny particles accumulate or coalesce.)

CC. Reactive metal - Metal which reacts with oxygen to form corrosion

EXAMPLE: Aluminum, magnesium

DD. Seam - Line formed by joining two pieces of metal

EE. Lap joint - In sheet metal construction, formed when one piece of metal is laid partly over another at the edges

FF. Recess - Receding part or space

EXAMPLES: Equipment bay, wheel well

GG. Emulsion type cleaner - Chemical cleaner that mixes with water or petroleum solvent to form an emulsion

(NOTE: This mixture will separate if allowed to stand. It is used to loosen soot or oxide films from the surface of an aircraft.)

HH. Porous - Full of pores

(NOTE: Fluids can penetrate a substance having this quality.)

II. Sacrificial corrosion - Method of corrosion protection in which a surface is plated with a metal less noble than itself

(NOTE: Corrosion will attack the plating rather than the base metal.)

JJ. Insulation - Material used to prevent passage of heat, electricity, or sound from one medium to another

TECHNICAL INFORMATION SUPPLEMENT #2 - Use of Aircraft Chemicals

It is important that an aircraft mechanic be skilled in proper application practices for the many chemicals used in corrosion control. To do this the mechanic must first thoroughly understand the manufacturer's instructions concerning the use of a specific chemical.

Many products are available for use in these processes. The following Technical Bulletins describe the properties, use, and precautions of some commonly used aircraft chemicals. Do not use these instructions for corrosion control work on airworthy aircraft, they have been selected for training purposes only and are subject to revision.

TECHNICAL INFORMATION SUPPLEMENT #2

ELDORADO CHEMICAL COMPANY, INC.
SPECIALIZED CHEMICAL PRODUCTS
6700 LOOKOUT ROAD • P.O. BOX 32567 • SAN ANTONIO, TEXAS 78216-0567 • (512) 653-2060 AND 653-9323

TECHNICAL BULLETIN

ELDORADO D-2

ALUMINUM DEOXIDIZER AND SMUT REMOVER

ELDORADO D-2, when dissolved in water, is used to remove smut and passivate aluminum surfaces following treatment by acid cleaners.

PROPERTIES:

1. Red granular powder
2. Does not etch aluminum
3. Safe on plastics and paint
4. Nonflammable
5. No vapor toxicity

USE:

D-2 is used for brightening and preventing stains on aluminum surfaces after acid cleaning or etching. Spray on or brush-on applications require a solution of one to two ounces of D-2 per gallon of water. Apply D-2 solution immediately after rinsing acid from the surface and while the surface is still wet. Contact time should be thirty seconds or longer. Rinse D-2 solution from the surface thoroughly with cold water.

Immersion processes require six to twelve ounces of D-2 dissolved per gallon of water.

Immersion time required is one to ten minutes followed by a cold water rinse.

PRECAUTIONS:

D-2 contains chromic acid. Prevent contact of D-2 or its solutions with oxidizable materials. Avoid skin contact. In case of accidental contact, wash with soap and water.

(NOTE: The following terms and definitions will help to clarify this technical bulletin.)

A. Passivate - Treatment of corrosion-resistant steels after welding Much of their corrosion resistance is due to the buildup of an invisible oxide film on the surface. After welding, this buildup will normally take place in service, but can be hastened by immersion in cold 20% nitric acid for approximately 30 minutes. This also removes any surface foreign particles.

B. Smut - Foreign particles on the surface

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TECHNICAL BULLETIN

DORADO KOTE #1

USE:

ELDORADO DORADO KOTE #1 produces a gold conversion coat on aluminum which provides outstanding corrosion protection for unpainted aluminum and affords an excellent base for paint.

PROPERTIES:

1. Odor - none
2. Color - red-brown
3. Toxicity - should be given the same consideration as chromic acid
4. Appearance - coarse powder
5. pH of solution - 1.2 to 2.2
6. Applicable specification - MIL-C-5541

METHOD OF USE:

DIP APPLICATION

1. Clean metal thoroughly with a good non-corrosive alkaline cleaner.
2. Rinse thoroughly with water.
3. Deoxidize with ELDORADO D-3 or D-1.
4. Rinse thoroughly with water.
5. Immerse in DORADO KOTE #1 at a concentration of 1 to 2 ounces per gallon. Immersion time will vary from 30 seconds to 5 minutes depending upon the aluminum alloy, solution concentration and bath temperature. Bath temperatures must be maintained in the range of 60° to 90°F. Tank should be constructed of plastic or stainless steel.
6. Rinse in cold water.
7. Dry in dryer at a temperature not to exceed 135°F, or dip in warm water not to exceed 135°F and allow to dry, or blow water off the aluminum with air until dry.

SPRAY APPLICATION OR BRUSH APPLICATION

1. Clean area to be DORADO KOTED with ELDORADO ED-305L to provide a water break free surface.
2. Rinse thoroughly with water.
3. Deoxidize by applying ELDORADO AC-5 or AC-12.
4. Rinse thoroughly with water.
5. Apply DORADO KOTE solution at 1½ to 2 ounces per gallon at room temperature with a nylon paint brush, plastic sponge or spray equipment. The solutions should be applied liberally until a color from golden to light brown is obtained.
6. Rinse with water and allow to dry.

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TECHNICAL BULLETIN

ELDORADO ED-500

ALKALINE WATERBASE CLEANER

ELDORADO ED-500 is an alkaline, waterbase, liquid concentrated cleaner used to remove oil, exhaust tract film, and traffic film from aircraft exteriors. It may also be used for cleaning cabin and baggage areas of aircraft interiors as well as gas trucks, ground service units, and freight-handling vehicles.

PROPERTIES:

1. Concentrated, powerful cleaner
2. Safe on plexiglas, paint, and electrical insulation
3. Nonflammable; no vapor toxicity
4. Safe on aluminum, magnesium, ferrous alloys, and high strength steel
5. Applicable specification: MIL-C-25769H
6. Biodegradable

USE:

For extremely heavy-duty cleaning such as exhaust tracts, mix one part ED-500 with four parts petroleum solvent. Air agitate the mixture to form a thick, creamy emulsion which may be applied by spray, mop, or brush. Allow a few minutes for penetration, then agitate with a brush and rinse thoroughly with water.

For ordinary aircraft cleaning, mix one part ED-500 with ten parts water. Apply by spray, agitate with a brush, and rinse thoroughly with water.

For cleaning aircraft interior surfaces, mix one part of ED-500 with twenty parts of water. Apply to surface being cleaned with a rag or window cleaning bottle (spray type). Pick up loosened dirt and ED-500 solution on a clean, dry rag. No other rinse is necessary. This procedure is used on hard non-porous surfaces such as metal, wood, and vinyl plastic.

For cleaning upholstery, rugs, and other soft surfaces, mix one part ED-500 with ten parts water. Wet a fiber bristle brush well with ED-500 solution and agitate the surface vigorously to generate foam. Pick up foam on a clean dry rag. Normally, this procedure is conducted in such a manner that the fabric surface is wet as little as possible.

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TECHNICAL BULLETIN

DORADOKOTE #7

NON-CHROMATE CONVERSION COAT

USE:

ELDORADO DORADOKOTE #7 contains no chromates and produces a gold to purple iridescent conversion coat on aluminum which provides outstanding corrosion protection for unpainted aluminum and affords an excellent base for paints.

PROPERTIES:

1. Odor - None
2. Color - Red
3. Appearance - Coarse Powder
4. pH of solution - 5

METHODS OF USE:

Dip Application

1. Clean metal thoroughly with a good non-corrosive alkaline cleaner.
2. Rinse thoroughly with water.
3. Deoxidize with a good aluminum deoxidizer such as Eldorado D-3 at 6-8 ounce per gallon.
4. Rinse thoroughly with water.
5. Immerse in Doradokote #7 at a concentration of 1 to 1¼ ounces per gallon. Immersion time will vary from 30 seconds to 5 minutes depending upon the aluminum alloy, solution concentration and bath temperature. Bath temperatures must be maintained in the range of 60° to 90°F. Tank should be constructed of plastic or stainless steel.
6. Rinse in cold water.
7. Dry in a dryer at a temperature not to exceed 135°F, or dip in warm water not to exceed 135°F and allow to dry or blow water off the aluminum with air until dry.

Spray application or Brush Application

1. Clean area to be Doradokoted #7 with Eldorado ED-349 or by any other convenient means which gives a water break free surface.
2. Rinse thoroughly with water.
3. Etch by applying Eldorado AC-12 for 10 minutes.
4. Rinse thoroughly with water.

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TECHNICAL BULLETIN

DORADOKOTE #7
Page 2

5. Apply Doradokote #7 at 1½ to 2 ounces per gallon at room temperature with a nylon paint brush, plastic sponge or spray equipment. The solution should be applied liberally until a color from a golden to light brown is obtained.
6. Rinse with water and allow to dry.

REMARKS:

As with any good metal finishing system, high quality results can be assured only if the metal is properly cleaned. When comparing the Doradokote #7 non-chromate conversion coating process with chromate processes it should be realized that chromic acid is a good cleaner in itself. Therefore aluminum surfaces must be deoxidized and clean before applying Doradokote #7. Proper cleaning procedures or special techniques for your specific requirements will be supplied upon request.

PRECAUTIONS:

Doradokote #7 is a hygroscopic powder which must be protected from the atmosphere. It must be kept in a tightly sealed container. Partially used drums must be carefully closed before returning to storage.

Some insoluble material will be noted in Doradokote #7 solutions. This is normal and should not be filtered off.

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TECHNICAL BULLETIN

ELDORADO MAG KOTE NO. 1

ELDORADO MAG KOTE NO. 1 is a chromic acid, conversion coating treatment for magnesium. It produces a gold-grey irridescent coating which provides corrosion protection and is a good base for paint adhesion.

PROPERTIES:

1. Red, thin liquid
2. Contains chromates
3. Non-flammable
4. No vapor toxicity
5. Applicable specification, MIL-C-3171C, Type I

USE:

Eldorado Mag Kote No. 1 is shipped ready for use and may be applied by dip application, spray-on, or brush and can be used for touch-up on areas where chemical treatment has been removed.

The solution is brushed on for one minute or until a grey to yellow-red irridecent coating forms. Parts are dipped for one-half to two minutes, or until gassing stops. Eldorado Mag Kote No. 1 is operated in a temperature range of 70°-90°F and the solution can be contained in stainless steel, mild steel lined with glass, ceramics, synthetic rubber or vinyl base material.

After dip operation, parts are to be held for approximately five seconds to allow for drain-off and to produce better colored coating. Parts then should be dipped in cold water, followed by a hot water dip rinse to facilitate drying.

The etching action of the solution prohibits its use on machine surfaces unless tolerances are allowed. Magnesium parts containing steel or brass may be given Eldorado Mag Kote No. 1 treatment. Racks should be made of 316 stainless steel.

PRECAUTIONS:

Avoid all skin contact through the use of rubber gloves, aprons and face masks. Treat as Chromic Acid Solution. Contact with combustible materials can cause fire.

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TECHNICAL BULLETIN

ELDORADO ASTROMAT B

ELDORADO ASTROMAT B is a liquid, solvent base, emulsion cleaner to be used on painted and unpainted metal surfaces of aircraft. ASTROMAT B is particularly suitable for cleaning of exhaust track and wheel well areas.

PROPERTIES:

1. Dark brown, clear liquid
2. Powerful cleaner, particularly for greasy soils
3. Flash point: None
4. Will not cause hydrogen embrittlement of high strength metals
5. Safe on aluminum, magnesium, cad plate, and other structural metals
6. Surfactants are biodegradable
7. Conforms to Type II of Douglas CSD-1 and Boeing D6-17487

USE:

ASTROMAT B may be mixed with water or with kerosene. Dilution with water should be one part ASTROMAT B with four parts water for heavy duty degreasing and one part to nine parts water for routine cleaning. Dilution with four parts kerosene may be used for removing oil spills and degreasing of engine parts.

Apply ASTROMAT B with mop, brush, or spray. Allow to remain on surface for 15 minutes; agitate surface with a brush and rinse with a pressure stream of water.

PRECAUTIONS:

Avoid contact with skin and eyes with rubber clothing and face shield. DO NOT use in confined spaces. In case of accidental contact with eyes, flush with water and contact a physician.

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TECHNICAL BULLETIN

ELDORADO ASTROMAT H

LIQUID CONCENTRATED CLEANER

ELDORADO ASTROMAT H is an alkaline, waterbase, liquid, concentrated cleaner used to remove oil, exhaust track film, and traffic film from aircraft exteriors. It may also be used for cleaning cabin and baggage areas of aircraft interiors, as well as gas trucks, around service units, and freight handling vehicles.

PROPERTIES:

1. Concentrated, powerful cleaner
2. Safe on plexiglas, paint, and electrical insulation
3. Nonflammable
4. Safe on aluminum, magnesium, ferrous alloys, and high strength steel
5. Applicable specifications: Douglas CSD-1
   Boeing D6-17487
6. Biodegradable

USE:

For extremely heavy duty cleaning such as exhaust tracks, mix one part ASTROMAT H with four parts petroleum solvent. Air agitate the mixture to form a thick, creamy emulsion which may be applied by spray, mop, or brush. Allow a few minutes for penetration then agitate with a brush and rinse thoroughly with water.

For ordinary aircraft cleaning, mix one part ASTROMAT H with ten parts water. Apply by spray, agitate with a brush, and rinse thoroughly with water.

For cleaning aircraft interior surfaces, mix one part ASTROMAT H with twenty parts of water. Apply to surface being cleaned with a rag or window cleaning bottle (spray type). Pick up loosened dirt and ASTROMAT H solution on a clean, dry rag. No other rinse is necessary. This procedure is used on hard, nonporous surfaces such as metal, wood, and vinyl plastic.

PRECAUTIONS:

Dilute with at least four parts water or solvents before use. Avoid prolonged skin contact.

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TECHNICAL BULLETIN

ELDORADO ED-305

WATER SOLUBLE SAFETY SOLVENT CLEANER

ELDORADO ED-305 is an alkaline solvent cleaner which rapidly cleans and floats away grease, oil, wax, carbon inks, mildew, and other stubborn soils yet requires no scrubbing and leaves no oily residue or film.

PROPERTIES:

1. Clean, yellow, alkaline liquid
2. Nonflammable
3. Contains no phosphates
4. Biodegradable
5. Noncorrosive

USE:

ED-305 is a powerful solvent cleaner which must be diluted with water for use. Difficult soils may require dilution with four parts water. Dilute one part ED-305 with 25 parts water for routine cleaning. Spray, mop, or wipe on surface to be cleaned and allow to dwell for 10 minutes. Rinse off with water, a wet cloth, or wipe off with a clean dry cloth.

PRECAUTIONS:

ED-305 has a powerful grease-dissolving action and will therefore defat the skin. Avoid skin contact with rubber gloves.

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TECHNICAL BULLETIN

ELDORADO DEGREASER

ELDORADO DEGREASER is a liquid, solvent, soluble, grease-emulsifying detergent to be used on painted and unpainted hard surfaces.

PROPERTIES:

1. Dark brown, clear liquid detergent
2. Powerful cleaner, particularly for greasy soils
3. Safe on paint and plexiglas
4. Flash point above 160°F
5. Soluble in kerosene or petroleum solvents
6. Safe on steel, aluminum, magnesium, cad plate, and other structural metals
7. Surfactants are biodegradable
8. Emulsifiable in water

USE:

DEGREASER may be mixed with water or with kerosene. Dilution with water should be one part Degreaser with four parts water for heavy duty degreasing and one part to nine parts water for routine cleaning. Dilution with four parts kerosene may be used for removing oil spills and degreasing of engine parts.

Apply Degreaser with mop, brush, or spray. Allow to remain on the surface for one hour or more; agitate the surface with a brush and rinse with a pressure stream of water.

PRECAUTIONS:

Avoid contact with skin and eyes through use of rubber clothing and face shield. Do not use in confined spaces. In case of accidental contact with eyes, flush with plenty of water and contact a physician.

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TECHNICAL BULLETIN

ELDORADO CT-2600

PARTS CLEANER

ELDORADO CT-2600 is a two-phase, liquid, solvent base, non-phenolic cleaner, paint remover, and carbon remover.

PROPERTIES:

1. Contains methylene chloride
2. Contains no phenols, chromates, or heavy metals
3. Used at room temperature
4. Contains a vapor barrier to prevent loss of solvent
5. Safe on all metals
6. Nonflammable
7. Surface-active agents are biodegradable
8. Powerful stripper for all paints

USE:

CT-2600 is used at room temperature as received in a mild steel tank. CT-2600 contains two layers as packaged in the drum; the top layer forming a liquid seal to prevent evaporation of active solvents from the lower portion. If a portion of a drum is used, agitate contents thoroughly before pouring.

Immerse parts completely in lower layer and allow to remain in the solution for 30 minutes or more as required. Rinse with pressure spray of water or immerse parts in over-flowing rinse tank.

Maintain depth of the upper layer at 2" per foot of lower layer by additions of water.

PRECAUTIONS:

DO NOT HEAT. Use at room temperature. CT-2600 contains chlorinated solvents and amines. Avoid all skin or eye contact with use of rubber clothing and face shields. Use with adequate ventilation.

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TECHNICAL BULLETIN

ELDORADO HT-2300

CARBON REMOVER AND PAINT STRIPPER

ELDORADO HT-2300 is a two-phase, hot tank type carbon remover and paint stripper. It is particularly recommended for removal of engine sludge and baked-on soils.

PROPERTIES:

1. Safe on all metals
2. Effective for removal of carbon, engine soils, and paint films
3. Long lasting
4. Applicable specification: MIL-C-25107B
5. Will not embrittle high strength steel
6. Surfactants are biodegradable
7. Low vapor toxicity
8. Flash point: above 160°F

USE:

HT-2300 may be ordered with or without seal. HT-2300 with seal is used as received at 140° - 160°F in a mild steel tank. HT-2300 without seal requires addition of 2" of water per foot of depth and addition of 0.1% sodium chromate.

Heat should be applied by steam, hot water, or electric elements; avoid open flame.

Immerse parts completely in lower layer for one hour or more until soils are removed or loosened. Rinse with pressure spray, steam, or petroleum solvent.

Avoid heavy contamination by oils and greases to increase tank life. Precleaning of parts with an alkaline cleaner may prove economical in high production situations.

Maintain upper layer at a depth of 2" per foot of depth of lower layer by daily additions of water.

PRECAUTIONS:

Since HT-2300 contains chlorinated solvents and cresylates, proper precautions should be taken to prevent contact with skin, eyes, or clothing. Use with adequate ventilation.

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TECHNICAL BULLETIN

ELDORADO PR-3420

POLYSULFIDE PAINT REMOVER

ELDORADO PR-3420 is a viscous, non-phenolic paint remover particularly effective for removal of latex, chlorinated rubber, and polyurethane paints.

PROPERTIES:

1. Effective for removal of acrylic, latex, polyurethane, and chlorinated rubber paints
2. Nonflammable
3. Low chromate content
4. Safe on aluminum, cadmium, magnesium, ferrous alloys, and high strength steel
5. Conforms to Corrosion Requirements of MIL-R-25134B

USE:

Spray or brush PR-3420 onto surface to be stripped. Allow thirty minutes to an hour for paint to be loosened; agitate to break remaining bond, then rinse with stream of water.

Conditions of humidity and temperature will dictate dwell time. PR-3420 should remain in contact with the paint for as long as possible without drying. Clean stripped surface with a good cleaner to remove all stripper residues.

PRECAUTIONS:

AVOID ALL SKIN CONTACT.

PR-3420 contains methylene chloride and must be used with adequate ventilation. When application is made on a large scale, full wash rack gear consisting of rubber boots, gloves, face mask, and rubber clothing should be worn to avoid contact of material with skin. If skin contact occurs, wash immediately with soap and water.

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TECHNICAL BULLETIN

ELDORADO PR-3500

PAINT REMOVER

ELDORADO PR-3500 is a high performance, solvent base, viscous stripper used to strip aircraft primers, epoxy, polyurethane, and other organic coatings from metal surfaces. It has a low chromate content and can be used in areas where industrial waste disposal permits only a limited amount of chromate to be used.

PROPERTIES:

1. Nonflammable
2. Low vapor toxicity
3. Contains phenol
4. Surfactants are biodegradable
5. Neutral pH
6. Safe on aluminum, cadmium, magnesium, ferrous alloys, and high strength steel

USE:

Spray or brush undiluted PR-3500 paint stripper onto surface. Allow a few minutes for the paint to be loosened; agitate to dislodge loosened paint, then rinse with a stream of water.

PRECAUTIONS:

If PR-3500 accidentally contacts the skin, flood the affected area with water. If further treatment is required, apply some ointment or salve to replace oils and soothe the skin. In case of contact with eyes, flush thoroughly with water and seek medical attention.

PR-3500 should be used with adequate ventilation due to the high chlorinated solvent content. When application is made on a large scale, full wash rack gear consisting of rubber boots, gloves, foul weather gear, and face mask should be worn to minimize contact of the material with the skin.

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TECHNICAL BULLETIN

ELDORADO PR-3700

PAINT REMOVER

ELDORADO PR-3700 is a viscous, non-phenolic, non-chromate, low odor paint remover, particularly effective for removal of aircraft finishes.

PROPERTIES:

1. Effective for removal of acrylic, epoxy, and polyurethane paints
2. Nonflammable
3. Contains no chromates or heavy metals
4. Safe on aluminum, cadmium, magnesium, and ferrous alloys
5. Biodegradable
6. Very low odor

USE:

Spray or brush PR-3700 onto surface to be stripped. Allow thirty minutes to an hour for paint to be loosened; agitate to break remaining bond, then rinse with stream of water.

Conditions of humidity and temperature will dictate dwell time. PR-3700 should remain in contact with the paint for as long as possible without drying. Clean stripped surface with a good cleaner to remove all stripper residues.

PRECAUTIONS:

AVOID ALL SKIN CONTACT.

ELDORADO PR-3700 contains methylene chloride and must be used with adequate ventilation. When application is made on a large scale, full wash rack gear consisting of rubber boots, gloves, face mask, and rubber clothing should be worn to avoid contact of material with skin. If skin contact occurs, wash immediately with soap and water.

DISPOSAL:

After methylene chloride has evaporated, PR-3700 can be flushed to sewer system.

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TECHNICAL INFORMATION SUPPLEMENT #2

ELDORADO CHEMICAL COMPANY, INC.

SPECIALIZED CHEMICAL PRODUCTS

6700 LOOKOUT ROAD • P.O. BOX 32567 • SAN ANTONIO, TEXAS 78216-0567 • (512) 653-2060 AND 653-9323

TECHNICAL BULLETIN

ELDORADO PR-4010

PAINT REMOVER

ELDORADO PR-4010 is a viscous, acid-activated, non-phenolic paint remover particularly effective for removal of polyurethane and epoxy paints from aircraft surfaces.

PROPERTIES:

1. Effective for removal of acrylic, alkyd, polyurethane, and epoxy paints
2. Nonflammable
3. Contains no phenol
4. Applicable specification: MIL-R-81903, Type III
5. Safe for use on aluminum, mild steel, titanium, and cad plate

USE:

Spray or brush ELDORADO PR-4010 onto surface to be stripped, allow twenty minutes to an hour for paint to be loosened; agitate to break remaining bond, then rinse with stream of water.

Conditions of humidity and temperature will dictate dwell time. Clean stripped surface with a good cleaner to remove all stripper residues.

PRECAUTIONS:

Avoid contamination with water. PR-4010 may cause pitting of aluminum or magnesium when contaminated with water.

Adequate ventilation is required due to presence of chlorinated solvents. Protective clothing, such as face shields, rubber gloves, and rubber aprons should be provided. In case of accidental contact with skin, wash thoroughly with soap and water, and rinse with alcohol containing 2% camphor. For eyes, flush with copious amounts of water, then seek medical attention.

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TECHNICAL INFORMATION SUPPLEMENT #2

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TECHNICAL BULLETIN

ELDORADO AC-6

CORROSION REMOVER

ELDORADO AC-6 is a liquid, viscous, acid cleaner and corrosion remover for use on aluminum and stainless steel surfaces. AC-6 contains a suface active agent to reduce the contact angle between water and aluminum surfaces. This causes water to flow off of the surface for fast drying.

PROPERTIES:

1. Viscous liquid for application to vertical surfaces and large structures.
2. Powerful cleaning action
3. Removes oxides and corrosion products
4. Etches glass
5. Biodegradable
6. Nonflammable
7. Safe on plexiglass and most plastics
8. Contains an agent to reduce metal-water interfacial tension.

USE:

Preclean surfaces with ELDORADO ED-500 to remove heavy greases and oils. Prevent contact of AC-6 with glass and high strength steel by masking. Apply AC-6 with a brush or with stainless steel spray equipment. Apply AC-6 starting from the lower surfaces and working up. Allow to remain in contact with the surface for one to five minutes. Aluminum will cause AC-6 to form a white foam. When this foam starts to slide, agitate the surface and rinse with water.

Aluminum alloys with a high copper content may turn dark after application of AC-6. This dark film can be removed by agitation with a brush while rinsing AC-6 from the surface or by application of ELDORADO D-2 solution immediately after rinsing AC-6 from the surface.

PRECAUTIONS:

Avoid skin contact by wearing rubber clothing and a face shield. In case of accidental contact, wash with soap and water. Avoid contact with eyes; if accidental contact occurs, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

DO NOT place Ac-6 in galvanized containers. ALWAYS use plasic.

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TECHNICAL INFORMATION SUPPLEMENT #2

ELDORADO CHEMICAL COMPANY, INC.

SPECIALIZED CHEMICAL PRODUCTS

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TECHNICAL BULLETIN

ELDORADO AC-190

METAL CONDITIONER AND RUST REMOVER

ELDORADO AC-190 is a liquid, inhibited, acid solution designed for removal of rust and preparation of ferrous surfaces for painting or other surface treatments.

PROPERTIES:

1. No flash point
2. pH: 1-2
3. Clear homogeneous liquid
4. Contains phosphoric acid
5. Applicable specification: MIL-M-10578C, Type III

USE:

Rust Removal:

Add one part AC-190 to two parts of water by volume. Remove heavy rust by wire brush and heavy grease with a grease solvent before applying compound. Apply diluted AC-183 by spray, dip, or flow brush. Allow conditioner to remain on metal surfaces long enough to either loosen or remove rust. Rinse with hot water. When the surface is dry, it may be coated, preserved with a corrosion preventative, or put directly in service.

Cleaning of steel parts:

Add one part AC-190 to four parts water by volume. Immerse parts for one hour or as long as required for removal of rust. Rinse thoroughly with water.

Phosphating:

Dilute AC-190 with 15 parts water. Spray or paint surface and allow to dry. After drying, the surface is ready for paint.

PRECAUTIONS:

Avoid skin contact through the use of rubber gloves, face shields, and rubber aprons.

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TECHNICAL INFORMATION SUPPLEMENT #2

ELDORADO CHEMICAL COMPANY, INC.
SPECIALIZED CHEMICAL PRODUCTS
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TECHNICAL BULLETIN

ELDORADO AC-12

CORROSION REMOVER

ELDORADO AC-12 is a liquid, viscous, acid cleaner and corrosion remover for use on aluminum aircraft surfaces.

PROPERTIES:

1. Viscous liquid for application to vertical surfaces and large structures
2. Powerful cleaning action
3. Removes oxides and corrosion products
4. Etches glass
5. Biodegradable
6. Nonflammable
7. Safe on plexiglas and most plastics
8. Applicable specification: MIL-C-38334, Amendment I

USE:

Preclean surfaces with ELDORADO ED-500 to remove heavy greases and oils. Prevent contact of AC-12 with glass and high strength steel by masking. Working from bottom to top to avoid streaking, apply AC-12 and allow to remain in contact with the surface for one to five minutes. Aluminum will cause AC-12 to form a white foam. When this foam starts to slide, agitate the surface and rinse with water.

PRECAUTIONS:

Avoid skin contact by wearing rubber clothing and a face shield. In case of accidental contact, wash with soap and water. Avoid contact with eyes. If accidentally contacted with eyes, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

DO NOT place AC-12 in galvanized containers. ALWAYS use plastic.

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TECHNICAL INFORMATION SUPPLEMENT #3 - Safety Precautions

The following rules are to be followed during aircraft cleaning and corrosion control procedures.

(NOTE: These are general safety precautions. Always check manufacturer's safety precautions.)

A. Do not use an open flame around aircraft chemicals unless specified by manufacturer

B. Always read all manufacturers' instructions concerning aircraft, equipment, and chemicals to be used in cleaning process

C. Make sure protective clothing is appropriate for job to be done

D. Be sure that aircraft is properly secured

(NOTE: Make sure chocks, tie-downs, and safety struts are in place.)

E. Alert all personnel before installing or removing any external power on the aircraft

(NOTE: External power should be removed during the cleaning process.)

F. Always use products in area with adequate ventilation

Electrochemical Series for Metal

Arranged in order of Electrode Potential (Nobility) Most Anodic — will give up electrons most easily.

Magnesium
Zinc
Clad 7075 Aluminum Alloy
Commercially Pure Aluminum (1100)
Clad 2024 Aluminum Alloy
Cadmium
7075-T6 Aluminum Alloy
2024-T3 Aluminum Alloy
Mild Steel
Lead
Tin
Copper
Stainless Steel
Silver
Nickel
Chromium
Gold
Most Cathodic — Least Corrosive

Any metal appearing before another in this series is anodic to any metal which follows it, and will be the one corroded when they are subject to galvanic action.

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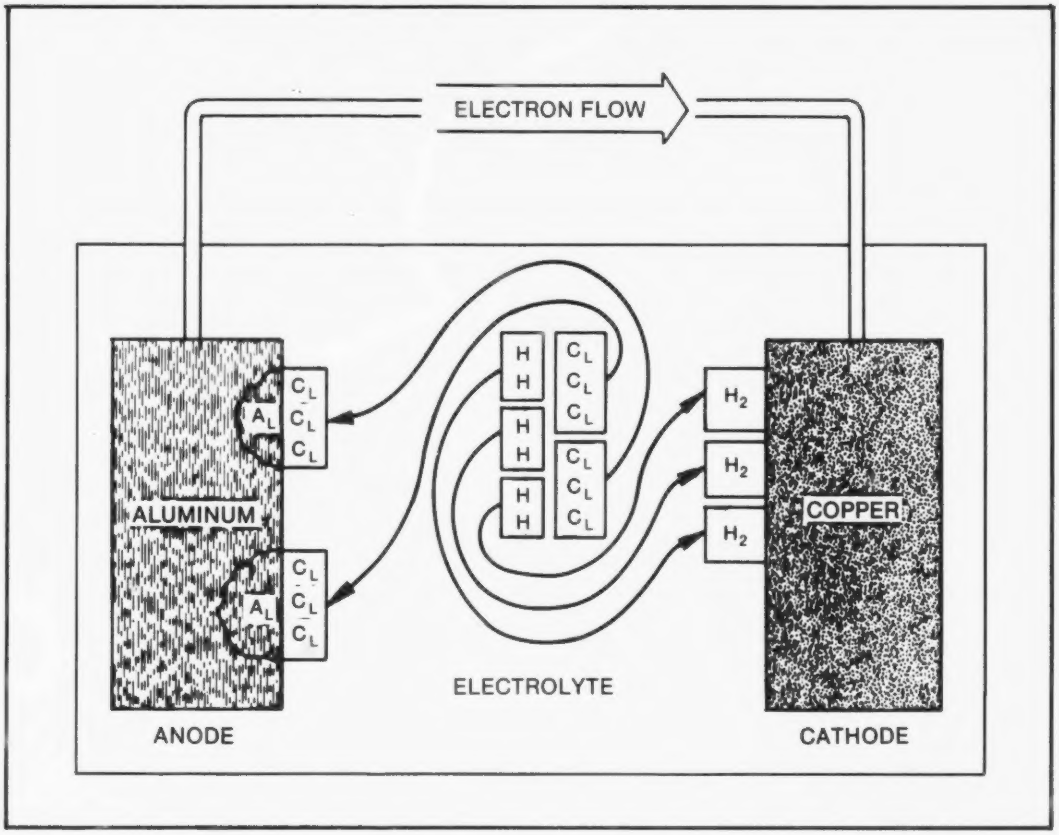
Electrolytic Action In A Battery


ELECTRON FLOW
H
H
H
H
H
H
C_L
C_L
C_L
C_L
C_L
C_L
A_L
C_L
C_L
C_L
A_L
C_L
C_L
C_L
ALUMINUM
H_2
H_2
H_2
COPPER
ELECTROLYTE
ANODE
CATHODE

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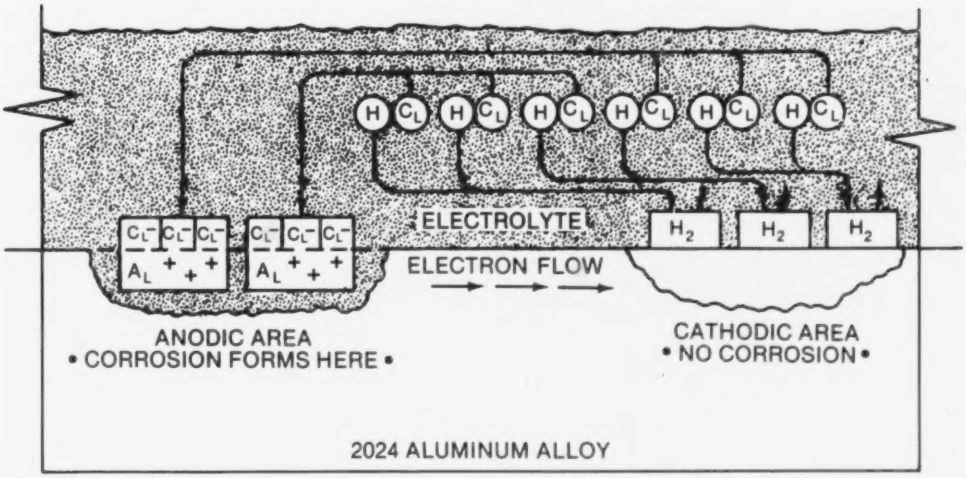
Electrolytics of Corrosion


H Cl H Cl H Cl H Cl H Cl H Cl
ELECTROLYTE
Cl⁻ Cl⁻ Cl⁻
Al + + +
Cl⁻ Cl⁻ Cl⁻
Al + + +
H2 H2 H2
ELECTRON FLOW
ANODIC AREA
• CORROSION FORMS HERE •
CATHODIC AREA
• NO CORROSION •
2024 ALUMINUM ALLOY

Aluminum alloys have both anodic and cathodic areas.

Corrosion will appear at the anodic area

when chlorine atoms from the electrolyte

join the aluminum to form aluminum chloride.

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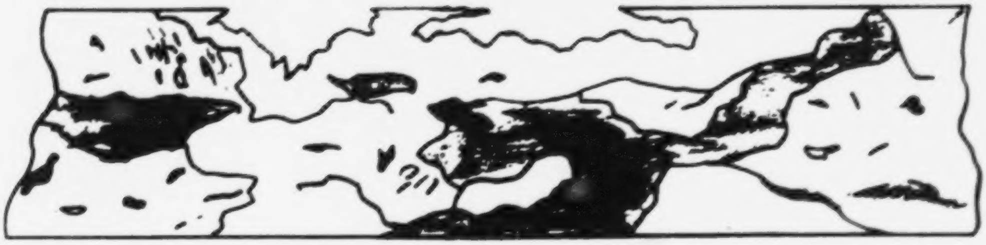
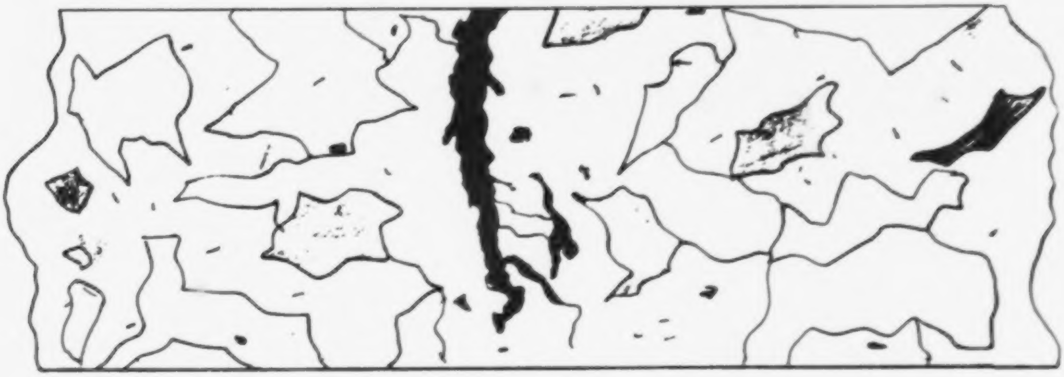
Types of Corrosion



Pitting Corrosion



Stress Corrosion

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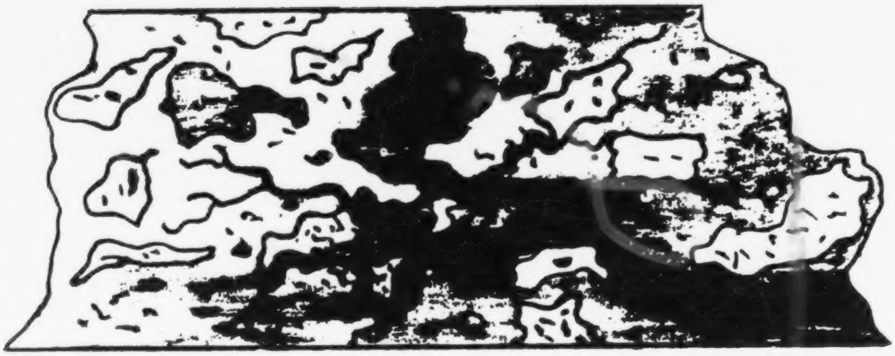
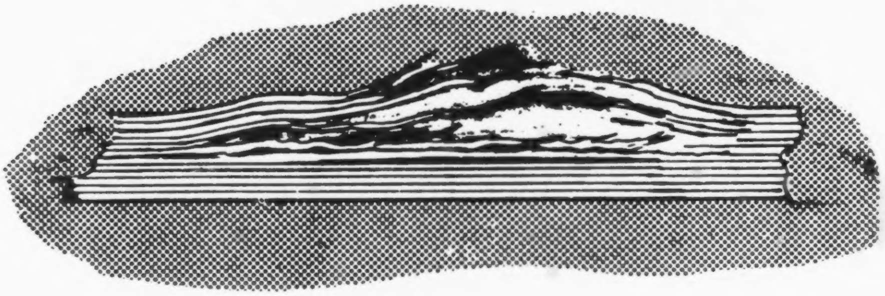
Types of Corrosion

(Continued)



Intergranular Corrosion



Exfoliation Corrosion

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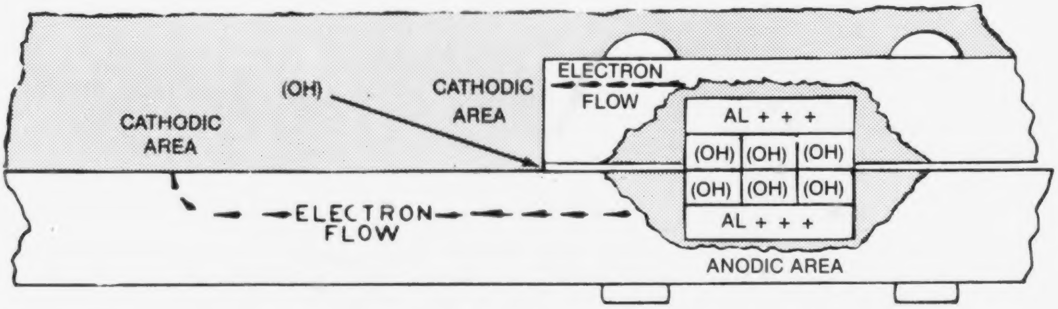
Types of Corrosion

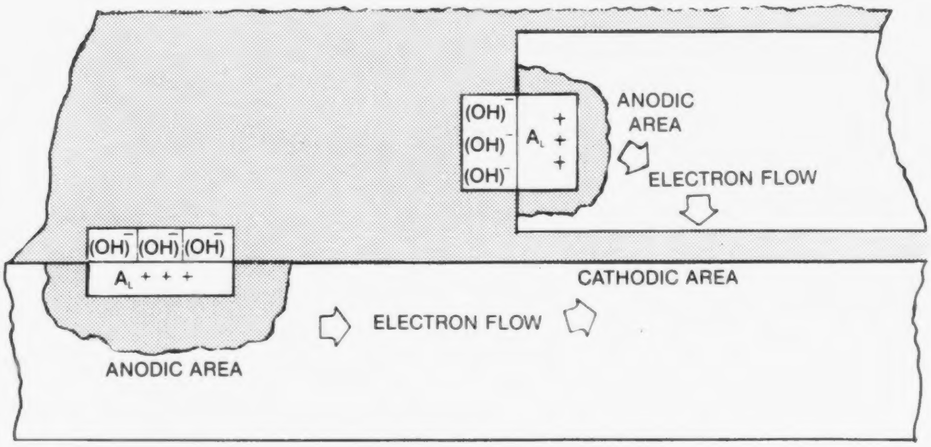
(Continued)

$2\,H_2O + O_2 + 4$ ELECTRONS → 4(OH)


CATHODIC
AREA
(OH)
CATHODIC
AREA
ELECTRON
FLOW
AL + + +
(OH) (OH) (OH)
(OH) (OH) (OH)
AL + + +
ELECTRON
FLOW
ANODIC AREA

Oxygen Concentration Cell Corrosion

$2\,H_2O + O_2 + 4$ ELECTRONS → 4(OH)


(OH)⁻
(OH)⁻
(OH)⁻
A_L + + +
ANODIC
AREA
ELECTRON FLOW
(OH)⁻ (OH)⁻ (OH)⁻
A_L + + +
CATHODIC AREA
ELECTRON FLOW
ANODIC AREA

Metallic Ion Concentration Cell Corrosion

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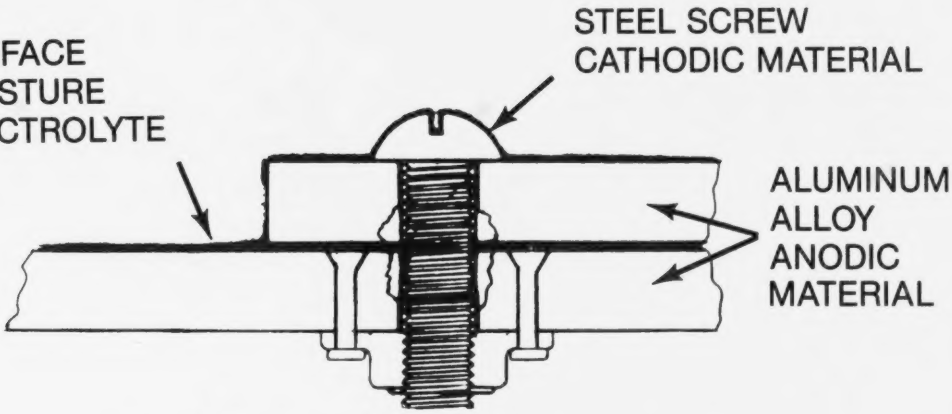
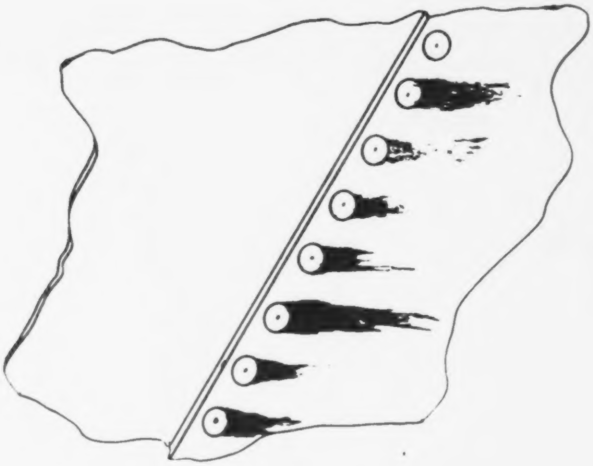
Types of Corrosion

(Continued)


STEEL SCREW
CATHODIC MATERIAL
SURFACE
MOISTURE
ELECTROLYTE
ALUMINUM
ALLOY
ANODIC
MATERIAL

Galvanic Corrosion



Fretting Corrosion

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Dissimilar Metals

Contacting Metals	Aluminum alloy	Cadmium plate	Zinc plate	Carbon and alloy steels	Lead	Tin coating	Copper and alloys	Nickel and alloys	Titanium and alloys	Chromium plate	Corrosion resisting steel	Magnesium alloys
Aluminum alloy				▨	▨	▨	▨	▨	▨	▨	▨	▨
Cadmium plate				▨	▨	▨	▨	▨	▨	▨	▨	▨
Zinc plate				▨	▨	▨	▨	▨	▨	▨	▨	▨
Carbon and alloy steels	▨	▨	▨				▨	▨	▨	▨	▨	▨
Lead	▨	▨	▨				▨	▨	▨	▨	▨	▨
Tin coating	▨	▨	▨				▨	▨	▨	▨	▨	▨
Copper and alloys	▨	▨	▨	▨	▨	▨						▨
Nickel and alloys	▨	▨	▨	▨	▨	▨						▨
Titanium and alloys	▨	▨	▨	▨	▨	▨						▨
Chromium plate	▨	▨	▨	▨	▨	▨						▨
Corrosion resisting steel	▨	▨	▨	▨	▨	▨						▨
Magnesium alloys	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	

Shaded areas indicate dissimilar metal contacts

Dissimilar metal contacts that will result in electrolytic corrosion

Corrosive Agents

Acids

Alkalis

Salts

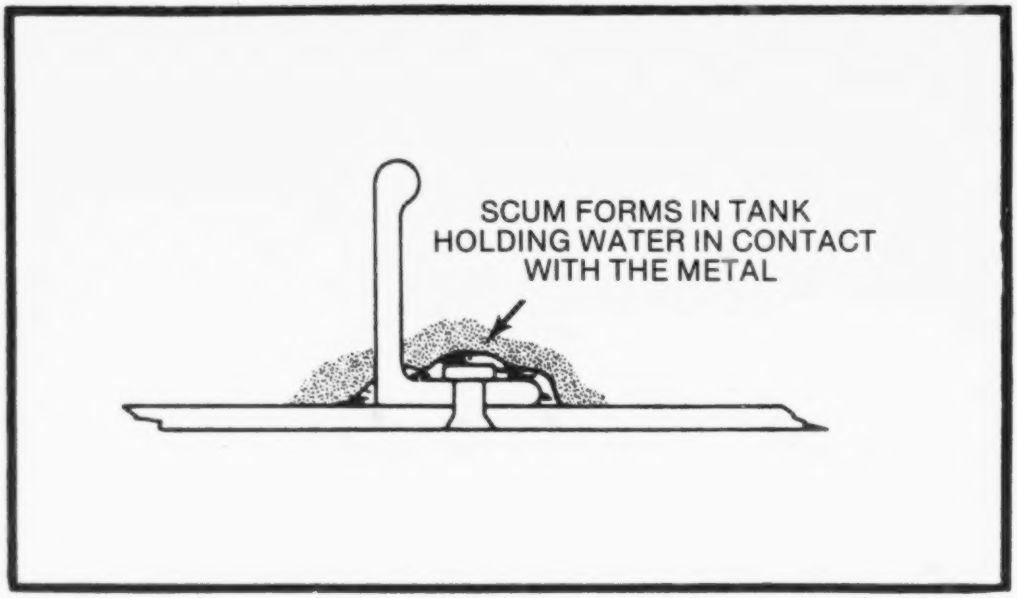
Mercury

Water

Air

Organic Growths

Microbial Growth


SCUM FORMS IN TANK
HOLDING WATER IN CONTACT
WITH THE METAL

Microbial growth within a turbine aircraft fuel tank

forms a scum that holds water

against the metal

and causes corrosion to form.

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Detection Methods for Corrosion

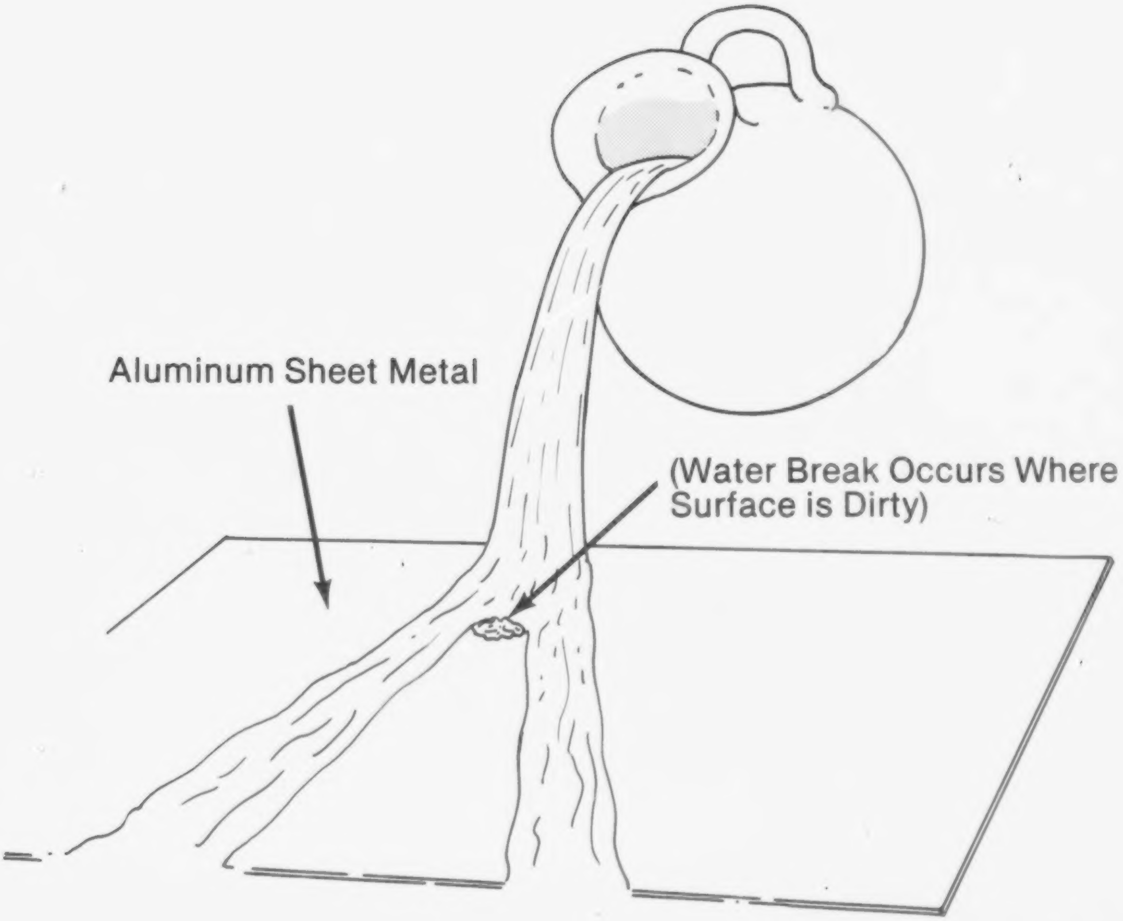
Visual Inspection

Dye Penetrant Inspection

Ultrasonic Inspection

Radiological (X-Ray) Inspection

Water Break Test


Aluminum Sheet Metal
(Water Break Occurs Where Surface is Dirty)

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

WORKBOOK SUPPLEMENT #1 - Use Technical Terms Related to Aircraft Cleaning and Corrosion Control

Let's have some fun while we learn the language of corrosion and corrosion control. Your progress will accelerate once you have mastered some basic terms, so let's see how quickly you can solve the following crossword puzzle.

DOWN

1. Device that generates electricity

2. Receding part or space

3. New entity formed by a union of elements or parts

4. Metal that contains no iron

5. Chemical liquid or gas - acid, alkaline, or salt - which will conduct electrical current by releasing ions to unite with ions on the electrodes

7. Smallest particle of an element; consists of a positively charged nucleus orbited by one or more negatively charged electrons

10. Chemical substance containing hydrogen, which has a characteristically sour taste, and is prone to react with a base or alkali to form a salt and accept electrons from the alkali

11. Chemical cleaner that mixes with water or petroleum solvent to form an emulsion

13. Two-component, chemically cured enamel finishing system, noted for its hard, flexible, high-gloss finish

18. To condense out of, or to separate from a mixture

21. Having the property of reacting with an acid to form a salt and giving up electrons to the acid material

25. Microscopic forms of animal life

27. Most basic particle of negative electricity

28. In sheet metal construction, formed when one piece of metal is laid partly over another at the edges

WORKBOOK SUPPLEMENT #1

ACROSS

1. Electrochemical process in which metal is transformed into powdery chemical compounds which have little mechanical strength

3. Negative plate of an electrochemical combination

4. Fit between two parts in which the part being put into a hole is larger than the hole itself

6. Iron or any alloy containing iron

8. Substance of different elements, one of which is a metal

9. Voltage existing between two terminals or two points of differing potential

12. Overlapping area of adjoining surfaces

14. Material used to prevent passage of heat, electricity, or sound from one medium to another

15. Positive plate of an electrochemical combination

16. Ranking of metals according to how easily each metal gives up its electrons

17. Smallest particle of an element or compound that is capable of retaining the chemical identity of the substance in mass

18. Full of pores

19. Stress produced in a body by forces acting along the same line but in opposite directions

20. Water held in suspension in aircraft fuel

22. State in which a base metal and alloying agents are united to form a single, solid metal

23. Line formed by joining two pieces of metal

24. Positively charged particles in the nucleus of an atom

26. List of metals arranged in an order which indicates the metal that gives up its electrons most readily

29. Metal which reacts with oxygen to form corrosion

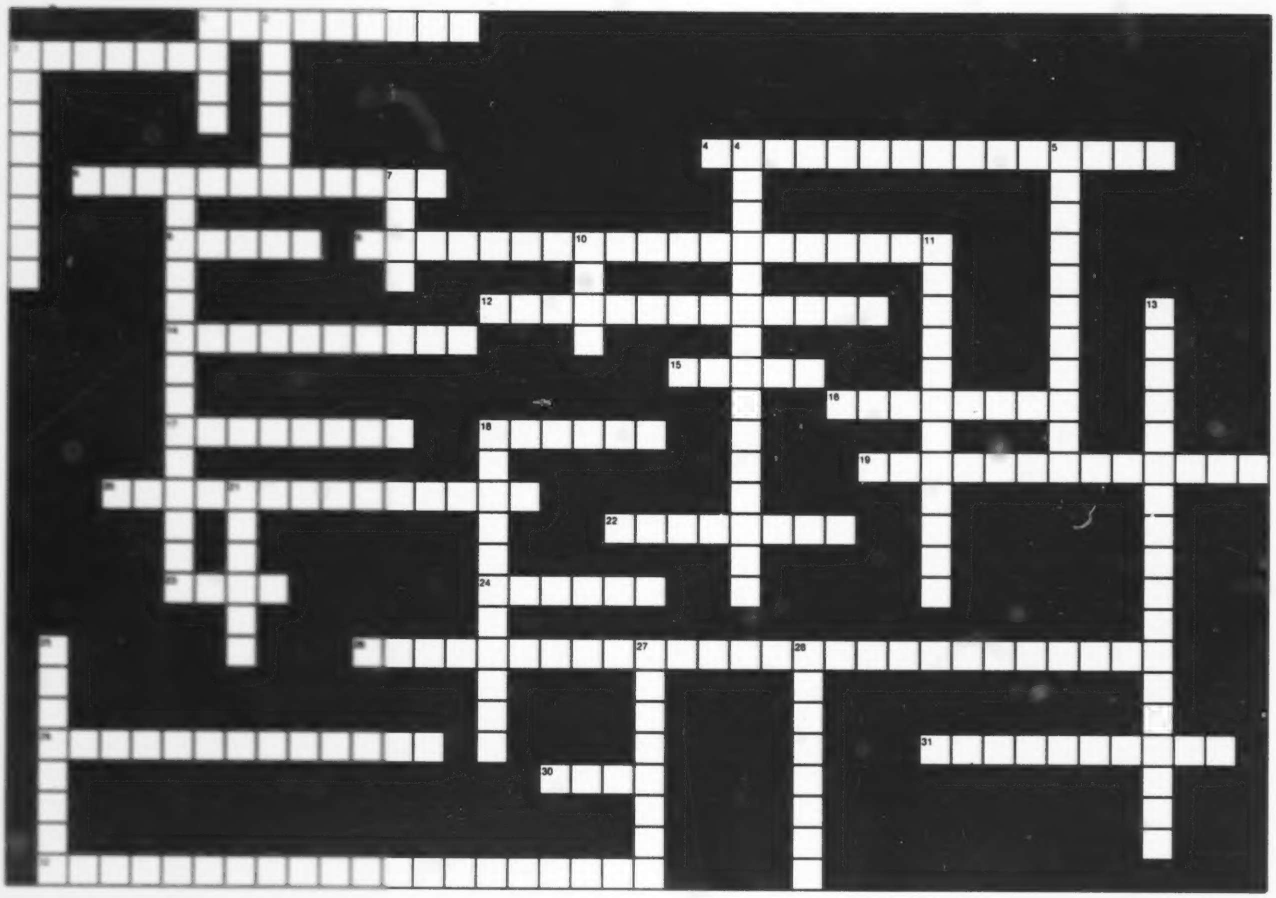
30. Result of combining an alkali with an acid

31. To form an alloy with mercury

32. Method of corrosion protection in which a surface is plated with a metal less noble than itself

WORKBOOK SUPPLEMENT #1

PUZZLE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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

WORKBOOK SUPPLEMENT #2 - Interpret Technical Information for Aircraft Corrosion Control

AIRCRAFT CLEANING - What does that mean? You're right. It means washing airplanes! But it's also quite a bit more. It's corrosion control. Without maintaining the highest standards of cleanliness for your aircraft they will soon become affected by the corrosive agents which contaminate their outer surfaces. Your aircraft will not only look bad but their strength will depreciate; and their service life will be greatly reduced. Save money, work and lives. Keep all your airplanes clean!

Using Technical Information Supplement #2, EA-ITP-G, AC 65-9A, AC 65-12A, and AC 43.13-1A complete the following statements. Write your answers in the blanks.

A. A good first step prior to the painting of engine crankcase is to clean it with a ______________________ solution.

B. ______________________ solvent would be used to remove grease from fabric prior to doping.

C. The advantage of water-soluble or water-base cleaners over other cleaning agents is that they are ____.

D. Plastic surfaces should be flushed with fresh water before cleaning with soap and water to prevent ____.

E. The solvent used to clean acrylics and rubber is _______________________.

F. Magnesium engine parts can be cleaned with a commercial solvent, decarbonized, and _______________________ or _______________________.

G. All flammable cleaning liquids should be handled only in approved containers or safety cans and should be appropriately __________________.

H. __________________________ solvent is recommended for wipedown of cleaned surfaces prior to painting.

I. ______________________ solvent may be used to clean metal surfaces and as a paint stripper for small areas.

J. _____________________________ would be the result of cleaning an aluminum surface with a caustic cleaning product.

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

WORKBOOK SUPPLEMENT #3 - Interpret Chemical Manufacturer's Technical Bulletins

The aircraft mechanic cannot accept second-hand information about the use of products on aircraft. The mechanic must be thoroughly familiar with the manufacturer's information on the chemicals choosen for the job. Always pay close attention to all precautions pertaining to chemicals being used. Make sure you have a thorough understanding of all precautions - your health and life depend on it.

Using Technical Information Supplement #2 answer the following questions. Write your answers in the blanks.

A. Degreasing

1. Which product(s) would be best suited for use as a general degreaser?

   ____

2. What is the flash point of this product(s)? ____________________

3. List the safety precautions related to use of this product.

   a. ____

   b. ____

   c. ____

   d. ____

4. How is this degreaser applied? ______________________________

   ____

B. Decarbonizing

1. Decarbonizing chemicals are hazardous to us because they contain

   ______________ solvents

2. Decarbonizing chemicals are utilized in ____________________ and

   __________________ tank methods

3. Why should decarbonizing chemicals never be exposed to open flame?

   ____

4. List all safety precautions related to decarbonizing chemicals.

   a.____

   b.____

   c.____

   d.____

C. General aircraft cleaning

1. The EA-ITP-G 6:II:40 refers to military specifications (MIL-C-25769) applicable to emulsion cleaners. Which product in Technical Supplement #2 carries the military specification number?________________

2. Explain how to mix Eldorado ED-500 for ordinary aircraft cleaning.

   ____

   ____

   ____

3. List four general safety precautions for emulsion-type cleaners.

   a.____

   b.____

   c.____

   d.____

4. Heavy-duty cleaning can be accomplished by mixing ED-500 with

   __________________ instead of water.

WORKBOOK SUPPLEMENT #4 - Interpret Manufacturers' Specifications and Recommendations

Protective coatings are used to prevent contaminants (corrosive agents) from coming in contact with the metal surfaces of the aircraft. The more contact the corrosive agents have with the surface of the aircraft's skin, the more corrosion will develop. Your job is to see that you understand how protective coatings provide this protection, how to maintain these coatings for as long as possible, and to insure these coatings are replaced in a safe and professional manner.

Using Technical Information Supplement #2, answer the following questions. Write the correct answer in the blanks.

A. What toxicity considerations should be given Dorado Kote #1?

B. To what military specification does Dorado Kote #1 conform?

C. Explain the immersion process of Dorado Kote #1.

D. What does it mean when a technical bulletin requires you to deoxidize?

E. What does it mean to have a water break free surface?

F. In which applicating process must you dry your material in a dryer not to exceed 135°F when using Dorado Kote #7?

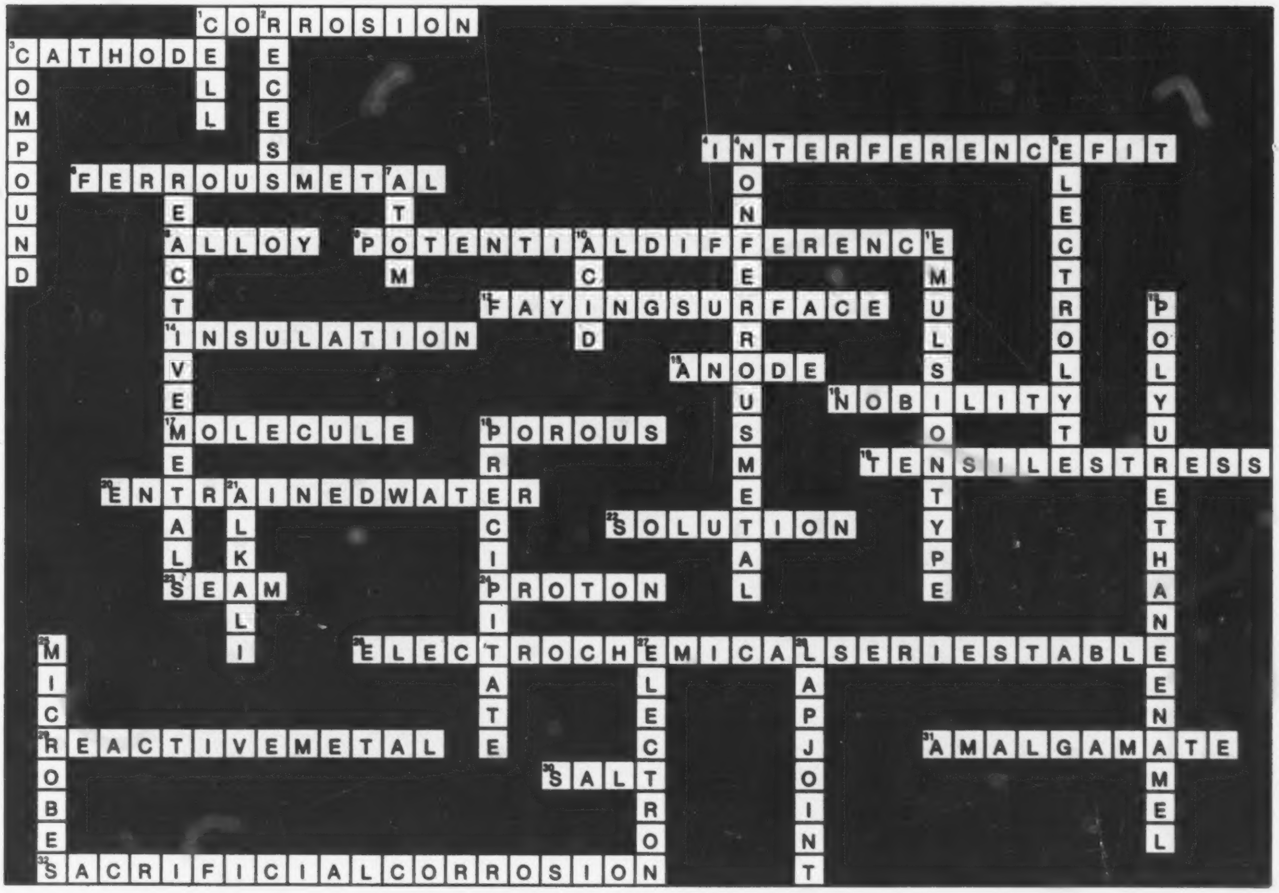
____

G. What is the major difference between Dorado Kote #1 and Dorado Kote #7?

____

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #1


CORROSION
CELL
RECESS
CATHODE
COMPOUND
INTERFERENCEFIT
NONFERROUSMETAL
ELECTROLYTE
FERROUSMETAL
ATOM
REACTIVEMETAL
ALLOY
POTENTIALDIFFERENCE
ACID
EMULSIONTYPE
FAYINGSURFACE
POLYURETHANEENAMEL
INSULATION
ANODE
NOBILITY
MOLECULE
POROUS
PRECIPITATE
TENSILESTRESS
ENTRAINEDWATER
ALKALI
SOLUTION
SEAM
PROTON
MICROBE
ELECTROCHEMICALSERIESTABLE
ELECTRON
LAPJOINT
REACTIVEMETAL
AMALGAMATE
SALT
SACRIFICIALCORROSION

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #2

A. Dichromate
B. Acetone
C. Non-flammable
D. Scratching
E. Aliphatic naphtha
F. Scraped, grit blasted
G. Labeled
H. Aliphatic naphtha
I. M.E.K., methyl ethyl ketone
J. Corrosion

Workbook Supplement #3

A. 1. Eldorado Degreaser, ED 305
   2. Eldorado Degreaser = above 160°F
   3. Precautions
      a. Avoid skin contact
      b. Use protective rubber clothing and face shield
      c. Do not use in confined spaces
      d. In case of accidental contact with eyes, flush with plenty of water; contact physician
   4. Mop, brush, or spray

B. 1. Chlorinated
   2. Hot, cold
   3. When exposed to open flame they are converted into extremely toxic gases
   4. a. Do not heat cold tank decarbonizer
      b. Do not expose to open flame
      c. Wear protective rubber clothing and face shield
      d. Use with adequate ventilation

C. 1. Eldorado ED-500 (Mil-C-25769)
   2. Mix one part ED-500 with ten parts water
   3. a. Wear protective clothing
      b. Use with adequate ventilation
      c. In case of contact with eyes flush with water
      d. Avoid prolonged skin contact
   4. Kerosene

Workbook Supplement #4

A. The same considerations as chromic acid

B. MIL-C-5541

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #4

C. Immerse in DORADO KOTE #1 at a concentration of 1 to 2 ounces per gallon Immersion time will vary from 30 seconds to 5 minutes depending upon the aluminum alloy, solution concentration and bath temperature. Bath temperatures must be maintained in the range of 60°F to 90°F. Tank should be constructed of plastic or stainless steel.

D. You are to use a chemical which will passivate and remove smut from aluminum surfaces following treatment by acid cleaners

E. Water will flow evenly and continously over a metal surface when that surface is clean and free from foreign particles. When the surface is not clean the water will break into segments.

F. Dip application

G. Dorado Kote #7 contains no chromates

PROJECT GUIDE #1 - Perform Aircraft Cleaning

PURPOSE:

To acquaint you with emulsion-type cleaners and processes associated with the general cleaning of exterior aircraft surfaces.

REFERENCE MANUAL:

A. EA-ITP-G 6:II:40-41

B. Manufacturer's product information on emulsion cleaner

C. Aircraft manufacturer's service manual

EQUIPMENT AND TOOLS NEEDED:

A. Rubber gloves

B. Aprons (optional)

C. Safety glasses

D. Water hose

E. Soft brush

F. Aircraft to be cleaned

G. Bucket

H. Aircraft manufacturer's service manual

SUPPLIES AND MATERIAL:

A. Emulsion type cleaner - Eldorado ED-500

(Note: The Eldorado ED-500 emulsion cleaner listed is not a required item, it is listed because it is part of Technical Information Supplement #3. Any emulsion cleaner of MIL-C-125769 specifications will be satisfactory.)

B. Soft, clean rags

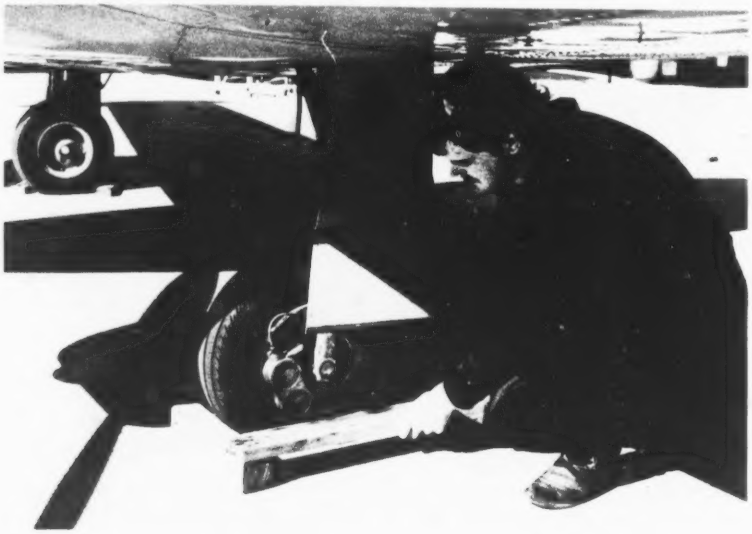
C. Water displacing lubricant approved by aircraft manufacturer

PROCEDURE:

A. Assemble all materials: emulsion-type cleaner, rags, bucket, soft brush, water hose and protective clothing.

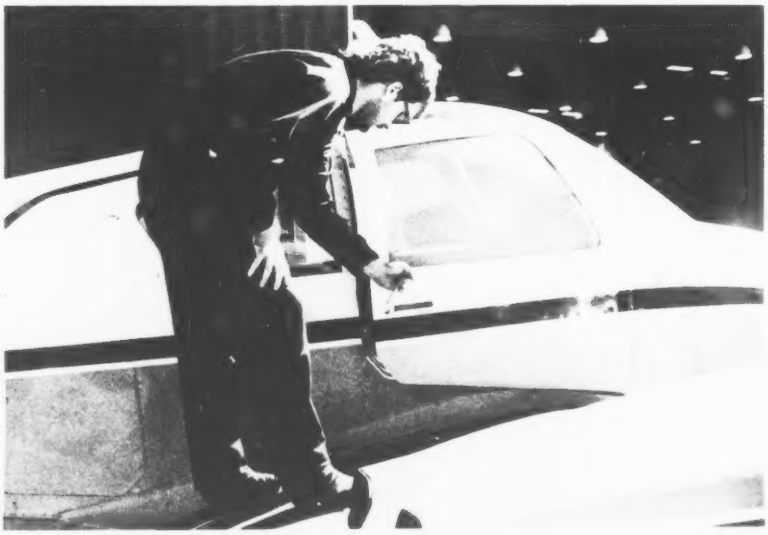
B. Chock both main wheels and tie down aircraft (Figure 1)

Figure 1



C. Prepare aircraft: Close aircraft windows, doors, cover static port and pilot tube to prevent water damage (Figure 2)

FIGURE 2



D. Install all maintenance struts or locking devices

E. Remove all electrical power from aircraft

(NOTE: Prior to removing electrical power, insure that all maintenance personnel around aircraft are aware the power is being removed.)

F. Attach water hose to outlet convenient to aircraft to be washed

G. Read any manufacturer's instructions related to aircraft cleaning (Figure 3)

FIGURE 3

H. Read the manufacturer's instructions which accompany Eldorado ED-500

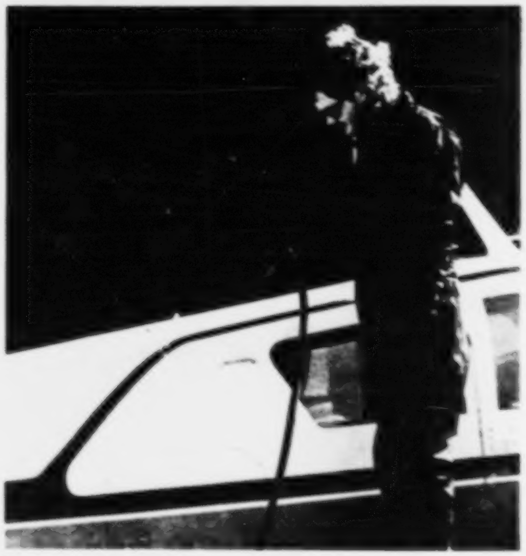
I. Put on protective clothing and eye protection

J. Mix Eldorado ED-500 with the appropriate amount of water

K. Rinse aircraft with water to eliminate dirt (Figure 4)

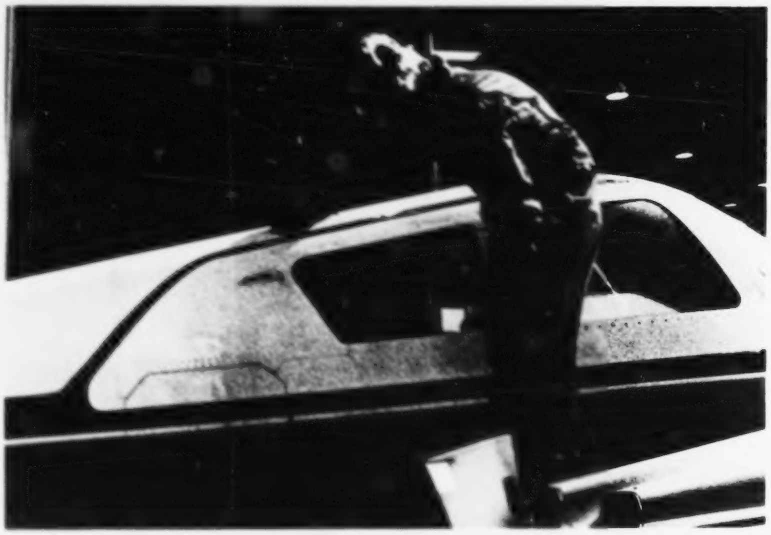
(NOTE: As much dirt as possible should be removed prior to rubbing aircraft surface with rags and brushes.)

FIGURE 4



L. Systematically apply pre-mixed solvent and water to small areas working from the top down using rags wet with solution (Figure 5)

FIGURE 5



(NOTE: Use soft brush only on stubborn soil.)

(CAUTION: Do not allow solvent to dry on aircraft.)

M. Lubricate all areas according to aircraft manufacturer's instructions (Figure 6)

(NOTE: Do not lubricate until aircraft has had a reasonable drying time.)

FIGURE 6

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

PROJECT GUIDE #2 - Perform Aircraft Corrosion Control

PURPOSE:

To allow you to develop skills in identification and removal of uniform surface corrosion from aircraft structures. Also to allow you to learn to apply protective coatings and perform any other relevant corrosion preventive processes.

REFERENCE MANUALS:

A. Aircraft Manufacturer's Manuals

B. Chemical Manufacturer's Manuals

EQUIPMENT AND TOOLS NEEDED:

A. Bucket and sponge

B. Safety glasses, rubber apron, and gloves

C. 5-10X magnifying glass

SUPPLIES AND MATERIALS:

A. Aluminum wool

B. Nylon Scrubber

C. Clean rags

D. Paint - Zinc chromate primer

E. ED-500

F. Doradokote #7

G. AC-12

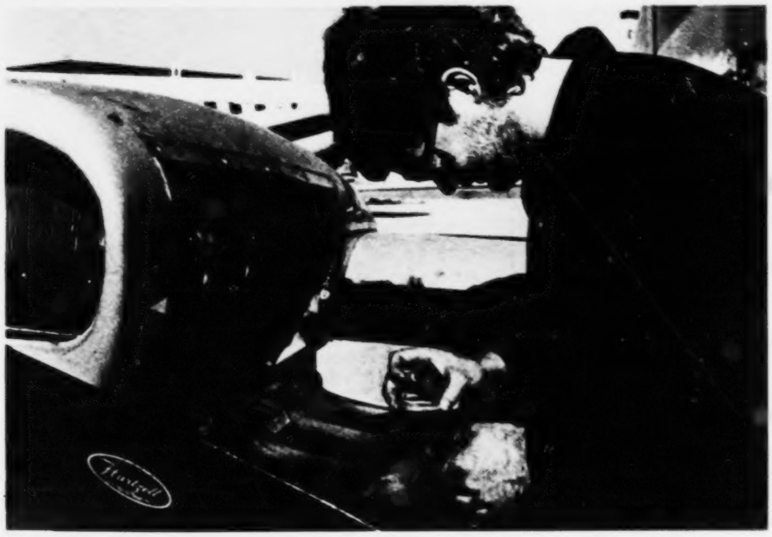
PROCEDURE:

A. Prepare aircraft for maintenance: Chock, tie-down, and remove electrical power

(NOTE: Follow all other applicable safety precautions.)

B. Using magnifying glass, inspect unpainted or primed aircraft surfaces for uniform surface corrosion of mild to moderate nature (Figure 7)

FIGURE 7



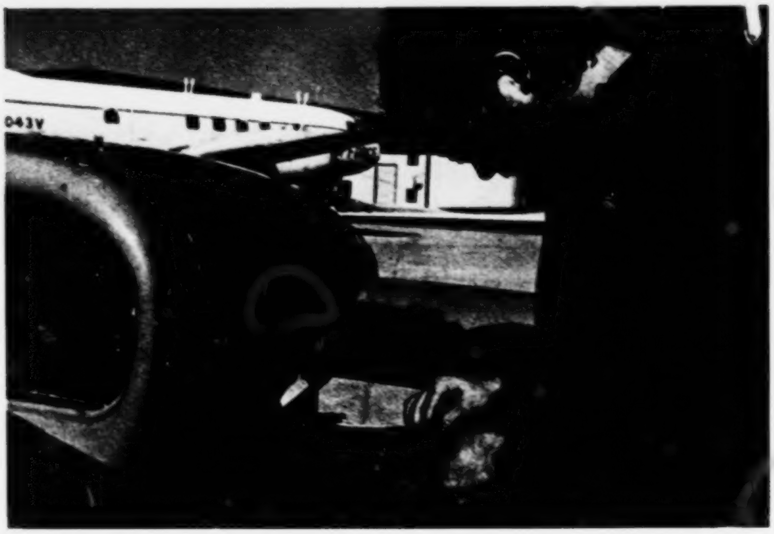
C. Put on protective clothing

D. Clean a small 6" x 6" area of corrosion

(NOTE: Read all aircraft and chemical manufacturer's instructions; mix ED-500 and water in small quantity in a bucket.)

E. Remove corrosion using first the aluminum wool and finishing with nylon scrubber (Figure 8)

FIGURE 8

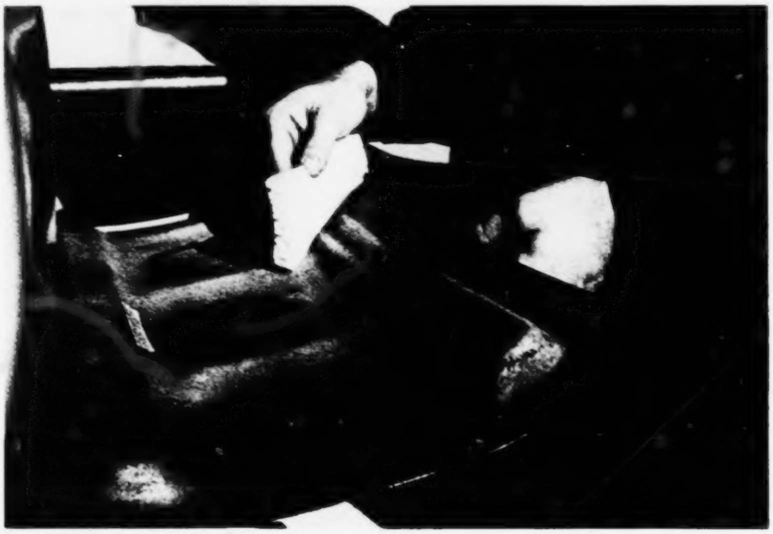


F. Rewash the area with ED-500 and water; allow to dry

G. Apply Dorado Kote #7 and AC-12 according to manufacturer's instructions (Figure 9)

(CAUTION: Be sure you are totally familiar with all safety precautions applicable to Dorado Kote #7 and AC-12.)

FIGURE 9



H. Prime area with zinc-chromate primer if necessary (Figure 10)

FIGURE 10

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

THEORY TEST

1. Match terms related to cleaning and corrosion control to their correct definitions. Write the correct numbers in the blanks.

_____a. Result of combinating an alkali with an acid

_____b. Overlapping area of adjoining surfaces

_____c. Chemical liquid or gas - acid, alkaline, or salt - which will conduct electrical current by releasing ions to unite with ions on the electrodes

_____d. Chemical substance containing hydrogen which has a characteristically sour taste and is prone to react with a base or alkali to form a salt and accept eletrons from the alkali

_____e. Stress produced in a body by forces acting along the same lines but in opposite directions

_____f. Ranking of metals according to how easily each metal gives up its electrons

_____g. Metal that contains no iron

_____h. Voltage existing between two terminals or two points of differing potential

_____i. State in which a base metal and alloying agents are united to form a single, solid metal

_____j. Device that generates electricity

1. Acid
2. Tensile stress (tension)
3. Salt
4. Electrolyte
5. Faying surface
6. Cell
7. Non-ferrous metal
8. Nobility
9. Solution
10. Potential difference electrode (pd)

_____k. Iron or any alloy containing iron

_____l. Substance of different elements, one of which is metal

_____m. Having the property of reacting with an acid to form a salt and giving up electrons to the acid material

_____n. To condense out of, or to separate from a mixture

_____o. Positive plate of an electrochemical combination

_____p. Microscopic forms of animal life

_____q. To form an alloy with mercury

_____r. Two-component, chemically cured enamel finishing system, noted for its hard, flexible, high-gloss finish

_____s. Metal which reacts with oxygen to form corrosion

_____t. Line formed by joining two pieces of metal

_____u. Water held in suspension in aircraft fuel

_____v. Fit between two parts in which the part being put into a hole is larger than the hole itself

_____w. Negative plate of an electrochemical combination

11. Alkali

12. Ferrous metal

13. Alloy

14. Microbes

15. Polyurethane enamel

16. Anode

17. Amalgamate

18. Precipitate

19. Entrained water

20. Reactive metal

21. Cathode

22. Seam

23. Interference fit

THEORY TEST

_____x. Electrochemical process in which a metal is transformed into powdery chemical compounds which have little mechanical strength

_____y. Smallest particle of an element; consisting of a positively charged nucleus orbited by one or more negatively charged electrons

_____z. In sheet metal construction, formed when one piece of metal is laid partly over another at the edges

_____aa. Most basic particle of negative electricity

_____bb. Smallest particle of an element or compound that is capable of retaining the chemical identity of the substance in mass

_____cc. New entity formed by a union of elements of parts

_____dd. Positively charged particles in the nucleus of an atom

_____ee. List of metals arranged in an order that indicates the metal that gives up its electrons most readily

_____ff. Full of pores

_____gg. Method of corrosion protection in which a surface is plated with metal less noble than itself

_____hh. Chemical cleaner that mixes with water or petroleum solvent to form an emulsion

_____ii. Material used to prevent passage of heat, electricity, or sound from one medium to another

_____jj. Receding part or space

24. Lap joint
25. Corrosion
26. Electron
27. Molecule
28. Proton
29. Atom
30. Compound
31. Recess
32. Emulsion type cleaner
33. Insulation
34. Electrochemical series table
35. Sacrifical corrosion
36. Porous

2. State facts related to the electrochemical origins of corrosion. Write the correct answer in the blank following each question.

   a. What is the basic unit of a chemical compound? ____________________

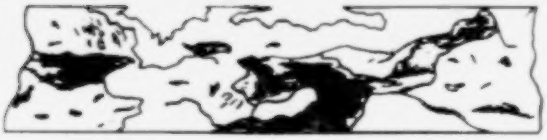
   b. What is the basic unit of a chemical element? ____________________

   c. What is the name of an atom that is electrically unbalanced? ________

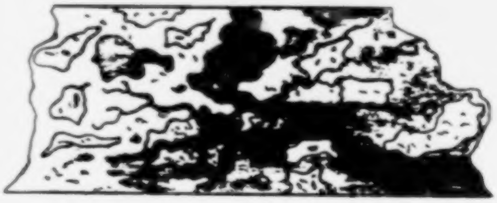
   d. What type of electrical charge is carried by an electron? ____________

   e. What is the name of an atom that has more electrons than protons? _____

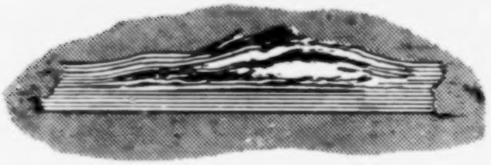
3. Identify common types of corrosion found in aircraft structures. Write the correct answers in the blanks.



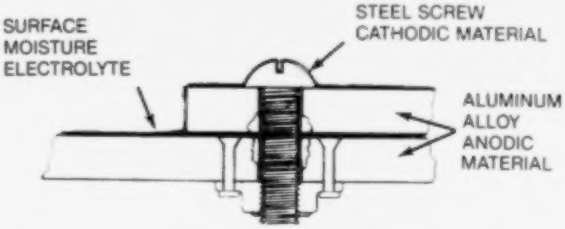
a. ______________________________



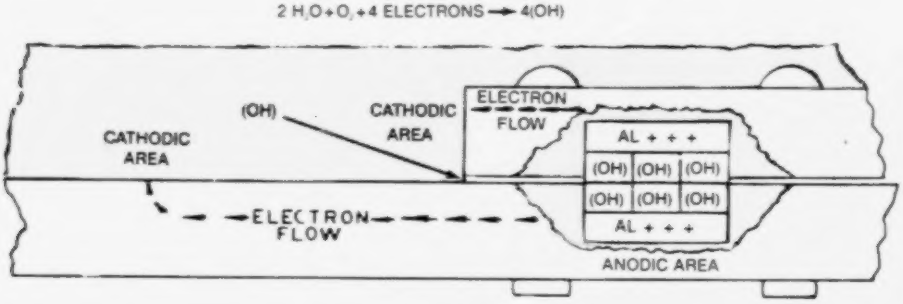
b. ______________________________



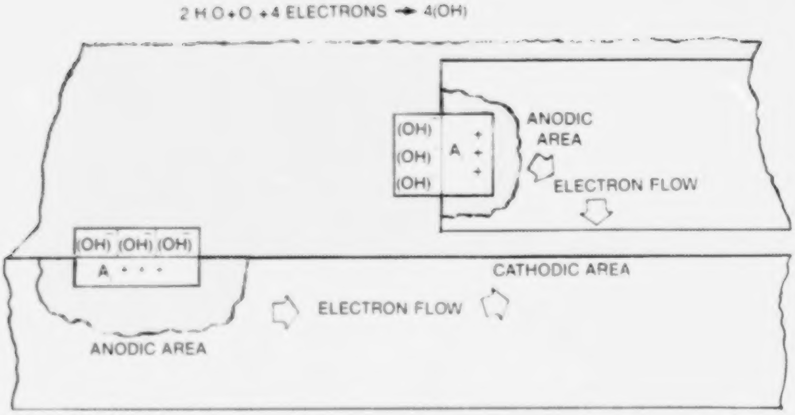
c. ______________________________


SURFACE MOISTURE ELECTROLYTE
STEEL SCREW CATHODIC MATERIAL
ALUMINUM ALLOY ANODIC MATERIAL

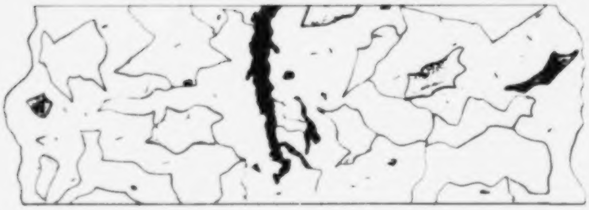
d. ______________________________

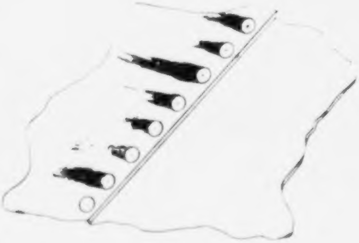

2 H2O+O2+4 ELECTRONS → 4(OH)
CATHODIC AREA
(OH)
CATHODIC AREA
ELECTRON FLOW
AL + + +
(OH) (OH) (OH)
(OH) (OH) (OH)
AL + + +
ELECTRON FLOW
ANODIC AREA

e. ____


2 H O+O +4 ELECTRONS → 4(OH)
(OH)
(OH)
(OH)
A
ANODIC AREA
ELECTRON FLOW
(OH) (OH) (OH)
A
CATHODIC AREA
ELECTRON FLOW
ANODIC AREA

f. ____





g. ______________________________ h. ______________________________

4. Select facts related to the origins of common types of corrosion. Circle the correct responses.

   a. Intergranular corrosion is caused by

      1. Improper heat treatment

      2. Dissimilar metal contact

      3. Improperly assembled components

      4. Poor application of zinc chromate primer

   b. Fayed surfaces cause concern in chemical cleaning because of the danger of

      1. Electrostatic charge buildup

      2. Electro-chemical attack

      3. Entrapping corrosive materials

      4. Corrosion by imbedded iron oxide

   c. Metals and alloys of greatly differing composition should not be in direct contact with each other because

      1. Of the possibility of generating static charges which interfere with radio reception

      2. Of the different rates of expansion

      3. Of their unequal tensile strengths

      4. Deterioration may result from electro-chemical action at point of contact.

   d. Corrosion caused by electrolytic action is the result of

      1. Excessive anodization

      2. Contact between two unlike metals

      3. The wrong quenching agent

      4. Excessive etching

e. The lifting or flaking of the metal at the surface due to delamination or grain boundaries caused by the pressure of corrosion residual product buildup is called

1. Brinelling
2. Electrolysis
3. Transgranulation
4. Exfoliation

5. List the most common types of corrosive agents.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

6. Name the four most common nondestructive methods used to detect corrosion.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

THEORY TEST

7. Match the most corrosion prone areas to the reasons for corrosion in these areas. Write the correct numbers in the blanks.

____a. Debris from the runway may be thrown into this area. Some of this debris will contain chemicals for ice control. These areas are also susceptible to concentration cell corrosion

____b. Alkaline and acidic fumes and materials used in this area are extremely corrosive

____c. Food can hold water which will promote corrosion; human waste is acidic and is a powerful corrosive agent

____d. Because of the inefficiency of our engines a great amount of heat, along with energy-rich gases, contains all the chemical materials for a potent electrolyte, and because of elevated heat corrosion forms rapidly

____e. In jet aircraft abrasion by high velocity air and contaminants removes protective coatings in this area

____f. These areas in the wings or empennage are difficult to inspect and clean. Special attention must be given these areas during corrosion removal and drains provided for any water which might accumulate

____g. There is danger of water or cleaning solvents becoming entrapped in this area. Also it is here that concentration cell corrosion frequently appears

____h. Organic growth in this area causes corrosion

____i. This area is susceptible to galvanic corrosion and it is also extremely difficult to clean and keep dry

1. Engine exhaust area
2. Battery compartments
3. Lavatories and food services area
4. Wheel wells and landing gear
5. Seams and lap joints
6. Engine inlet areas
7. Fuel tanks
8. Piano hinges
9. Control surface recesses

_____j. Cooper, lead, tin, and other metals used in this area make it a target for corrosion

_____k. Flux may concentrate in these areas and it is extremely corrosive

_____l. Carbon steel type, if left unprotected and water gets in, will corrode quickly; this will be difficult to detect

_____m. One of the most highly stressed areas in an aircraft structure and also one of the least accessible

_____n. Heavy current from the starter returns to the battery through this structure

_____o. All forms of liquid and solid debris can accumulate in this area with a high degree of inaccessibility. Usually has many drain holes but these can become clogged with debris

10. Bilge areas
11. Landing gear boxes
12. Engine mount
13. Control cable
14. Welded areas
15. Electronic equipment

8. Select facts related to cleaning engine parts, metal, fabric, acrylics, and rubber. Circle the correct answers.

   a. Why is a plastic surface flushed with fresh water before it is cleaned with soap and water?

      1. To prevent crazing
      2. To prevent scratching
      3. To remove oil land grease
      4. To prevent softening the plastic

   b. What solvent is used to clean acrylics and rubber?

      1. Aliphatic naphtha
      2. Methyl ethyl ketone
      3. Aromatic naphtha
      4. Methyl chloroform

c. How may magnesium engine parts be cleaned?

  1. Soak in a 20 percent caustic soda solution
  2. Wash with gasoline
  3. Spray with MEK (methyl ethyl ketone)
  4. Wash with a commercial solvent, decarbonize, and scrape or grit blast

d. Which of the following materials would be used to clean an engine crankcase prior to painting?

  1. Dichromate solution
  2. Acetone
  3. MEK (methyl ethyl ketone)
  4. 20 percent caustic soda solution

e. What effect does a caustic cleaning product have on aluminum structures?

  1. Electrochemical
  2. Mechanical
  3. Strengthening
  4. Corrosive

f. What solvent is used to clean metal surfaces and is also used as a paint stripper for small areas?

  1. Kerosene
  2. Methyl ethyl ketone
  3. Dry-cleaning solvent
  4. Methyl chloroform

g. Which solvent is recommended for removing grease from fabric prior to doping?

  1. Kerosene
  2. Acetone
  3. Toulene
  4. Turpentine

h. Which solvent is recommended for wipedown of cleaned surfaces just before painting?

1. Aliphatic naphtha
2. Trichlorethane
3. Dry-cleaning solvent
4. Kerosene

9. State five rules related to safety practices used during aircraft cleaning and corrosion control processes.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

e. ____

____

10. Perform aircraft cleaning

(NOTE: Test question 10 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

11. Arrange in order the steps for proper paint removal on aircraft structures. (Number these steps, starting with "1", in the correct order.)

_____a. Reapply the remover if necessary

_____b. Scrape the old paint away with a plastic or aluminum scraper

_____c. Mask areas not to be stripped with aluminum foil

_____d. Make a test of the paint remover on a piece of similar material

_____e. Daub the remover onto the surface using a brush ____f. Thoroughly clean the surface

____g. Rinse off remover and old paint using hot water or live steam

____h. Assess damage and determine course of action

12. State facts related to the proper mechanical and chemical corrosion removal techniques for aluminum alloys.

    a. Why must steel wool never be used to remove corrosion deposits from aluminum alloy parts? ______________________________

    ____

    b. What can be used to remove mild corrosion deposits from the surface of aluminum alloy? ______________________________

    c. What size glass beads would be used to remove corrosion by the abrasive grit blasting method? ______________________________

    d. After examination of the aircraft structure with a magnifying glass reveals all the corrosion is gone, how much more material should be removed to make sure the ends of all the intergranular cracks have been reached? ______________________________

13. Explain the chemical neutralization process for aluminum alloys.

    ____

    ____

    ____

    ____

    ____

14. List and describe the protective coatings used on aluminum alloys.

    a. ____

    ____

    ____

    b. ____

    ____

    ____

c. ____

____

____

15. Complete statements related to mechanical methods for removing corrosion from ferrous metals. Write the correct answers in the blanks.

    a. The best means of removing rust from steel is the ________________ process.

    b. ________________ ______________ on unplated steel parts is the best way to remove corrosion.

    c. ________________ ______________ ______________ must never have their corrosion removed by using a wire brush.

    d. On highly stressed steel parts use ________________ ______________ abrasive and extreme caution.

16. Complete statements related to the surface treatments for ferrous metals. Write the correct answers in the blanks.

    a. When the ______________ or ____________ plating process is used an electrolytically deposited coating forms an airtight covering over the surface of the metal with which it will be in contact.

    b. ___________ plating is a form of sacrificial corrosion.

    c. ___________ is a process which uses a coating of zinc on the metal.

17. Select processes used for corrosion control of magnesium parts. Circle the correct answers.

    a. To prevent corrosion between dissimilar metal joints in which magnesium alloy is involved.

        1. Prime only the magnesium part with one coat of zinc chromate primer and put a leather gasket between the pieces

        2. Plate the magnesium part with the same metal as the part that it will be in contact with

        3. Coat both mating surfaces with an aluminized varnish

        4. Prime both parts with two coats of zinc chromate primer and place a layer of pressure sensitive vinyl tape between them

b. Corrosion should be removed from magnesium parts with a

1. Steel wire brush
2. Carborundum abrasive
3. Stiff, hog-bristle brush
4. Steel burnishing tool

18. Match corrosion preventive techniques to corrosion prone areas. List number(s) of the correct preventive techniques in front of the areas. A blank may have more than one correct answer.

_____a. General exterior surfaces

_____b. Interior areas

_____c. Steel fasteners in aluminum

_____d. Skin lap joints

_____e. Sealers and sealants

1. Treat holes with alodine, then prime with zinc chromate; installed wet fastener
2. If one skin is magnesium use two coats of zinc chromate primer and .033 inch pressure-sensitive vinyl tape
3. Remove exhaust stains with proper solvents
4. Apply a corrosion inhibited film
5. Remove debris from drain openings
6. Use only manufacturer's approved substitute
7. Clean with emulsion-type cleaners
8. Apply a good organic film (paint)

19. Perform aircraft corrosion control.

(NOTE: Test question 19 is a project guide. It is an important part of the test. If it has not been completed, check with your instructor.)

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
PERFORM AIRCRAFT CLEANING AND CORROSION CONTROL
G102-B

ANSWERS TO THEORY TEST

1. a. 3
   b. 5
   c. 4
   d. 1
   e. 2
   f. 8
   g. 7
   h. 10
   i. 9
   j. 6
   k. 12
   l. 13
   m. 11
   n. 18
   o. 16
   p. 14
   q. 17
   r. 15
   s. 20
   t. 22
   u. 19
   v. 23
   w. 21
   x. 25
   y. 29
   z. 24
   aa. 26
   bb. 27
   cc. 30
   dd. 28
   ee. 34
   ff. 36
   gg. 35
   hh. 32
   ii. 33
   jj. 31

2. a. Molecule
   b. Atom
   c. Ion
   d. Negative charge
   e. Negative ion

3. a. Pitting corrosion
   b. Intergranular corrosion
   c. Exfoliation corrosion
   d. Galvanic corrosion
   e. Oxygen concentration cell corrosion
   f. Metallic ion concentration cell corrosion
   g. Stress corrosion
   h. Fretting corrosion

4. a. 1
   b. 3
   c. 4
   d. 2
   e. 4

5. a. Acids
   b. Alkalis
   c. Salts
   d. Mercury
   e. Water
   f. Air
   g. Organic growth

ANSWERS TO THEORY TEST

6. a. Visual
   b. Dye penetrant
   c. Ultrasonic
   d. Radiological

7. a. 4
   b. 2
   c. 3
   d. 1
   e. 6
   f. 9
   g. 5
   h. 7
   i. 8
   j. 15
   k. 14
   l. 13
   m. 11
   n. 12
   o. 10

8. a. 2
   b. 1
   c. 4
   d. 1
   e. 4
   f. 2
   g. 2
   h. 1

9. a. Do not use an open flame around aircraft chemicals unless specified by manufacturer

   b. Always read all manufacturer's instructions concerning the aircraft, equipment, and chemicals to be used in the cleaning process

   c. Make sure protective clothing is appropriate for job to be done

   d. Make sure that aircraft is properly secured

   e. Alert all aircraft personnel before installing or removing any external power on the aircraft

   f. Always use product in area with adequate ventilation

10. Performance skills evaluated to the satisfaction of the instructor

11. a. 7
    b. 6
    c. 4
    d. 3
    e. 5
    f. 1
    g. 8
    h. 2

12. a. Bits of steel will become embedded in the aluminum and will cause corrosion

    b. A nylon scrubber

    c. 500

    d. 2 thousandths

ANSWERS TO THEORY TEST

13. Remove all corrosion products, then treat the surface with 5 percent chromic acid solution to neutralize any remaining corrosion. After the acid has been on the surface for 5 minutes, wash with water and allow to dry

14. a. Cladding - to protect the surface of an aluminum alloy by the addition of a coating of pure aluminum

    b. Surface oxide film - forms when the surface of an aluminum alloy is converted to a film of aluminum hydroxide which drys to an aluminum oxide

    c. Organic film - Where a coating of paint is used to protect the metal

15. a. Mechanical
    b. Abrasive blasting
    c. Highly stressed areas
    d. Fine grit

16. a. Nickel Chrome
    b. Cadmium
    c. Galvanizing

17. a. 4
    b. 3

18. a. 3,4,5,7,8
    b. 4,5,7,8
    c. 1
    d. 2
    e. 6

19. Performance skills evaluated to the satisfaction of the instructor

PRACTICAL TEST #1 - Instructor's Guide

I. Student Activity - The student will be required to perform a magnetic particle inspection in accordance with FAA and industry standards. The student must use the correct references, select the correct magnetic particle mediums, and determine the number, size, and location of the defects within specified time limits and using proper safety practices.

II. Preparation for test

A. Select or create 12"-by-12" pieces of aluminum sheet metal with surface corrosion

B. Review the attached evaluation form

C. Have the student provide you with the practical test guide and evaluation form from the student guide

(NOTE: For reference, a copy of the student guide has been placed in the Instructor's Guide.)

D. Fill out the student guide for the assigned part

E. Provide the student with the parts and student guide

F. Provide the student with a selection of possible manuals to be used in this procedure including the required manuals

G. Provide the student with a selection of equipment and chemicals to use in the procedure including the required items

H. Monitor the student's performance and record the results on the evaluation form

I. Inspect the work at completion of the mechanical corrosion removal, application of the corrosion preventive coatings and application of the primer coating

J. Calculate scores on evaluation form and determine student rating

K. Discuss the student's performance

L. Reteach and retest as necessary

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PRACTICAL TEST #1 - Student Guide

I. INTRODUCTION

Modern aircraft are made of lightweight metals which are highly reactive to contaminants in the atmosphere. Salt air from coastal regions and industrial contaminants from urban areas attack aluminum alloy and magnesium structures.

Corrosion is a natural process and its prevention is almost impossible; but it can be controlled. The aviation maintenance technician must prevent or remove one or more of the requirements for corrosion. In doing this, he goes a long way in adding longevity to the structure of the airplane.

Cleanliness of the surface is one of the best ways to control corrosion. When moisture is held in contact with the metal surface by an accumulation or dirt or grease, corrosion is sure to start. If the surface can be kept perfectly dry and clean, however, corrosion has little chance of getting started. The essence of corrosion control is therefore prevention rather than removal.

Once corrosion has formed, all the technician can do is to remove every trace of the corrosion products treat the surface to form a protective, non-porous oxide film, and restore the protective and decorative finish.

II. Part to be inspected ________________________________

III. Type of corrosion ________________________________

IV. Reference manuals and technical publications

A. ________________________________

B. ________________________________

C. ________________________________

D. ________________________________

E. ________________________________

V. Discuss the corrosion control process to be used for this specific type of corrosion.

VI. List cleaning and corrosion preventive chemicals to be used in this process.

A. ____________________

B. ____________________

C. ____________________

D. ____________________

E. ____________________

(NOTE: Be sure to have your instructor check your work after completing each of the following process items.)

Item no. 6 - Performed mechanical corrosion removal correctly

Item no. 8 - Applied corrosion preventive coating correctly

Item no. 9 - Applied primer coating correctly

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PRACTICAL TEST #1 - Perform Aircraft Cleaning and Corrosion Control

Name: ______________________________ Date: ____________________

Performance Evaluation Key

Student's performance is typical of an: Point value

A = Exceptionally competent worker = 5
B = Above average worker = 4
C = Average worker = 3
D = Below average worker = 2
E = Incompetent worker = 1

Degree of Importance Factors

To be multiplied by performance evaluation key letter value

5 - Critical
4 = Essential
3 = Important
2 = Necessary
1 = Least important

(EVALUATOR NOTE: Circle the appropriate letters earned and make the necessary calculations to determine score.)

Item No.		PROCESS (195 pts. possible) A	B	C	D	E			
1.	Identified type of corrosion correctly	5	4	3	2	1	x	4 =	____
2.	Selected and used manuals and technical publications correctly	5	4	3	2	1	x	5 =	____
3.	Determined applicable corrosion control operations manual	5	4	3	2	1	x	4 =	____
4.	Selected appropriate cleaning chemical	5	4	3	2	1	x	3 =	____
5.	Performed cleaning process correctly	5	4	3	2	1	x	3 =	____
6.	Performed mechanical corrosion removal correctly	5	4	3	2	1	x	4 =	____
7.	Selected correct corrosion preventive coating	5	4	3	2	1	x	4 =	____

PRACTICAL TEST #1

Item No.		PROCESS A	 B	 C	 D	 E				
8.	Applied corrosion preventive coating on subsurface defects	5	4	3	2	1	x	3	=	____
9.	Applied primer coating correctly	5	4	3	2	1	x	4	=	____
10.	Worked safely	5	4	3	2	1	x	5	=	____
		Total process score							=	____

Item No.		PRODUCT (80 pts. possible) A	 B	 C	 D	 E				
11.	Surface condition of metal after mechanical corrosion removal completed	5	4	3	2	1	x	5	=	____
12.	Surface condition of metal after application of corrosion preventive coatings	5	4	3	2	1	x	4	=	____
13.	Surface condition of metal after application of primer coating	5	4	3	2	1	x	4	=	____
14.	Used time economically	5	4	3	2	1	x	3	=	____
		Total process score							=	____
		Total product score							+	____
		Total Test score								____

(NOTE: You must receive an "A" rating on item numbers 2, 10, and 11. If those items are passed, then the acceptable passing score is 195. To determine passing score, average all items except those requiring an "A" rating. Add the total points for the required "A" ratings to the total average points.)

Example: Items 2,10,11 requires an "A" rating
3 items x 25 points = 75 points
Average Score of 11 items = 120 points

Passing score = 195 points

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

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INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
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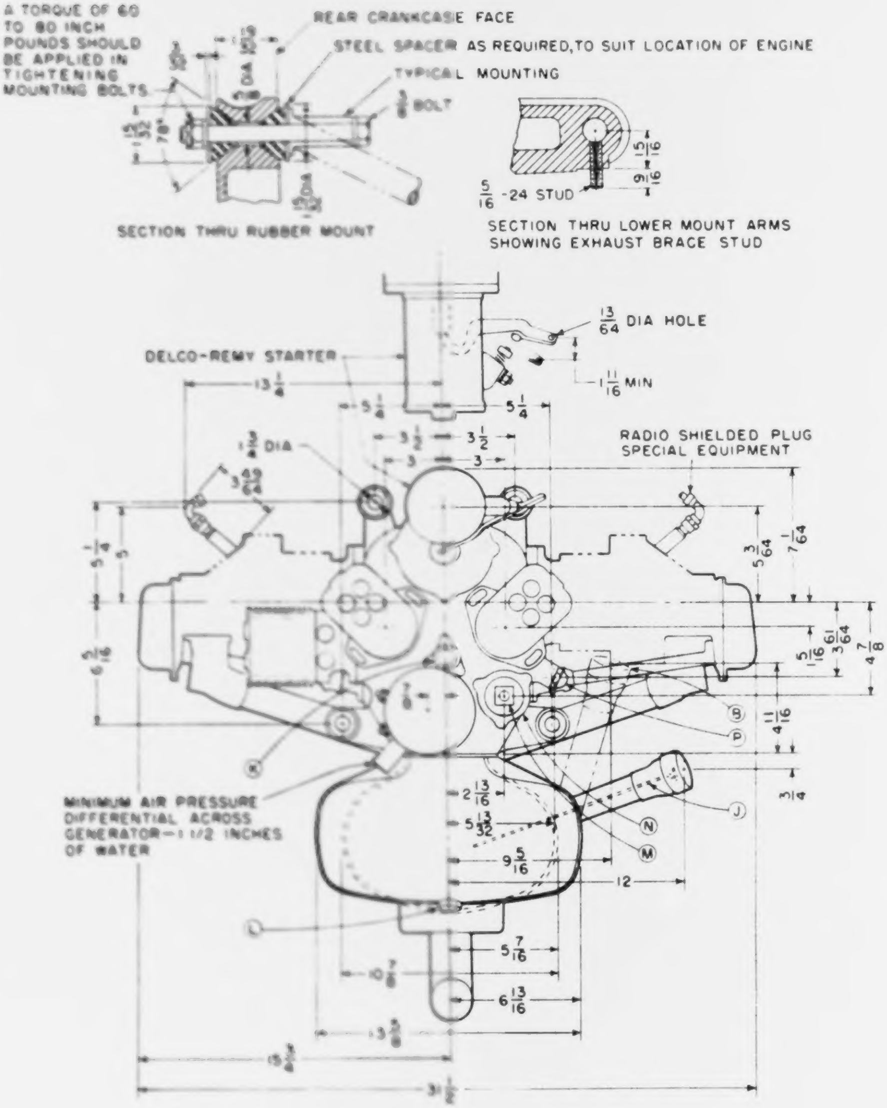
A TORQUE OF 60 TO 80 INCH POUNDS SHOULD BE APPLIED IN TIGHTENING MOUNTING BOLTS
REAR CRANKCASE FACE
STEEL SPACER AS REQUIRED, TO SUIT LOCATION OF ENGINE
TYPICAL MOUNTING
3/8 BOLT
7/8"
SECTION THRU RUBBER MOUNT
15/16
9/16
5/16 -24 STUD
SECTION THRU LOWER MOUNT ARMS SHOWING EXHAUST BRACE STUD
13/64 DIA HOLE
1 11/16 MIN
DELCO-REMY STARTER
13 1/4
5 1/4
5 1/4
1 3/4 DIA
3 1/2
3 1/2
3
3
3 43/64
RADIO SHIELDED PLUG SPECIAL EQUIPMENT
5 1/4
5
6 5/16
5 3/64
7 1/64
5/16
3 61/64
4 7/8
4 11/16
3/4
B
P
K
J
N
M
L
MINIMUM AIR PRESSURE DIFFERENTIAL ACROSS GENERATOR—1 1/2 INCHES OF WATER
2 13/16
5 13/32
9 5/16
12
5 7/16
10 7/8
6 13/16
13 3/8
15 3/4
31 1/2

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24. TM #24--Steps in Blocking in a View

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I. Answers to Theory Test

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INTRODUCTION

Drawings are a highly effective means of communication in the aviation industry. The lines, notes, symbols, and abbreviations used to construct aircraft drawings provide a wealth of information to the knowledgeable aviation maintenance technician. Every part found on an aircraft structure, from the simplest nut or bolt to the most complex assemblies, began as an idea expressed in the form of a drawing.

MODULE OBJECTIVE

After completion of this module, you will be able to use drawings, symbols, schematic diagrams, blueprint information, graphs, and charts to find specific information and dimensions needed by the aircraft maintenance technician. You will also be able to draw sketches of repairs and alterations. You will demonstrate this knowledge by completing the procedures outlined in the workbook assignments. You will further demonstrate this knowledge by scoring 85 percent on the module theory test.

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SPECIFIC OBJECTIVES

After completion of this module you will be able to:

1.	Match terms related to blueprints and drawings to their correct definitions. (1)	EA-ITP-G 4:I:1-25 Technical Supplement #1
2.	Identify types of aircraft drawings. (2)	EA-ITP-G 4:I:1-10 Figures 1-1 through 1-12
3.	Use orthographic exercises to construct missing views and lines. (3)	EA-ITP-G 4:I:11 Workbook Supplements #1-#5
4.	Identify types of sectional views. (2)	EA-ITP-G 4:I:5 Technical Supplement #2
5.	Make sketches using appropriate sketching techniques. (3)	Workbook Supplements #6-#8
6.	Make three-view sketches of isometric sketches or drawings. (3)	EA-ITP-G 4:I:11 Workbook Supplements #9-#10
7.	Match types of pictorial views to their correct descriptions. (1)	EA-ITP-G 4:I:12
8.	Make isometric sketches. (3)	Workbook Supplements #11-#14
9.	Identify types of lines commonly found on blueprints. (2)	EA-ITP-G 4:I:12-14 Workbook Supplement #15 Technical Supplement #3
10.	Determine dimensions and notes on aircraft blueprints. (3)	EA-ITP-G 4:I:15 Workbook Supplement #16
11.	Determine tolerancing for dimensions on aircraft drawings. (3)	EA-ITP-G 4:I:15 Workbook Supplement #17 Technical Supplement #4
12.	Name information found in the title block of an aircraft drawing. (1)	EA-ITP-G 4:I:16-18
13.	Describe uses of fuselage station numbers, water lines, buttock lines, and wing station numbers. (2)	EA-ITP-G 4:I:18-19

SPECIFIC OBJECTIVES

14.	Interpret information on graphs (3)	EA-ITP-G 4:I:24-25 Workbook Supplement #18
15.	Perform basic geometric exercises. (3)	EA-ITP-G 4:I:18-21 Workbook Supplements #19-#22
16.	Interpret an aircraft drawing. (3)	EA-ITP-G 4:I:1-10 Figure 1-1 -I:1-12 Aircraft Drawings Workbook Supplement #23

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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Implementation Suggestions

(NOTE: Have students read material related to the specific objectives. Much of this reading can be homework assignments.)

Estimated Teaching Time		Theory	Lab
Objective 1	At the beginning of this module, briefly review the terms listed on Technical Supplement #1. Drill students on terms as they appear or as they are mentioned in covering various topics in the module. At the end of the module, review terms again to make sure each term is thoroughly understood.		
Objective 2	Refer to each of the types of aircraft drawings in Figures 1-1 through 1-12 in EA-ITP-G 4:1. Explain carefully the characteristics and uses of each type of drawing. Use actual blueprints from industry to illustrate each type of drawing in addition to the text material and Transparency Masters #1-#10.		
Objective 3	Explain the basic principles of orthographic projection. Use EA-ITP-G 4:I:11. Use Transparency Masters #11-#12 to emphasize the view relationships. Have students select objects in the room to visualize. Apply the principles by completing Workbook Supplements #1-#5.		
Objective 4	Illustrate the principles of sectional views by allowing students to examine various aircraft parts that have been cut with a saw to expose the interior portion of the part. Review EA-ITP-G 4:I:5, 13 and 14. Go over Technical Supplement #2 and compare the various types of sectional drawings and their application.		

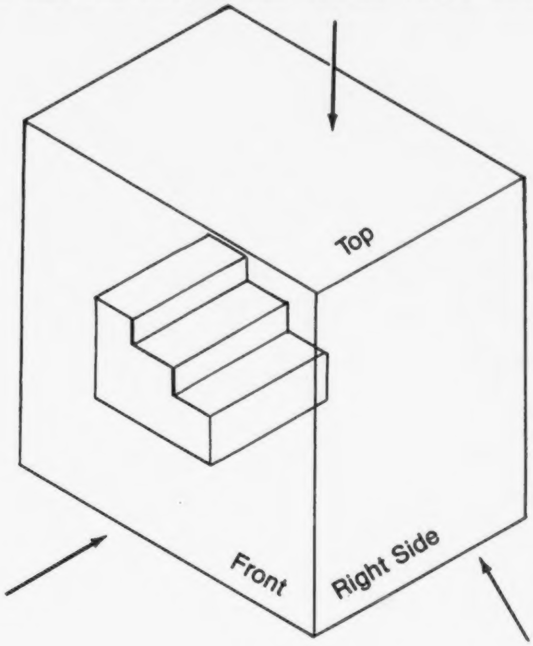
INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 5	Demonstrate basic sketching techniques, using actual aircraft parts. Allow students to practice making horizontal, vertical, inclined curved, and circular lines prior to doing Workbook Supplements #6-#8. Encourage students to practice sketching simple everyday objects to develop a feel for proportion and spacing. Use Transparency Masters #22-#24.		
Objective 6	Apply the basic principles of orthographic projection to sketch one-, two-, and three-view drawings in Workbook Supplements #9 and #10. Review Transparency Masters #11-#21 to clarify principles of projection.		
Objective 7	Discuss and illustrate the basic differences between the three types of pictorial drawings. Use EA-ITP-G 4:I:12 to support discussion. Explain why the isometric type of pictorial is realistic in appearance, yet simple enough to draw with basic projection techniques. Use Transparency Master #25.		
Objective 8	Review basic isometric principles and methods of construction. Use Transparency Masters #26-#28 to illustrate basic relationships of views and surfaces. Demonstrate basic techniques. Have students complete Workbook Supplements #11-#14.		
Objective 9	Review EA-ITP-G 4:I:13 and demonstrate the use of each line by calling attention to lines on actual aircraft drawings. Have students practice with a straightedge, copying the basic lines in the text and on Transparency Master #29.		

Estimated Teaching Time		Theory	Lab
Objective 10	Discuss the precision to which aircraft parts must be made and how critical the dimensions are to insure proper fit and operation. Instruct students to look on the title block, in notes, and on the drawing itself to find dimensions.		
Objective 11	Demonstrate the comparison of fractional and decimal dimensions in expressing limits of tolerance in decimals, or in fractions. Refer to Transparency Masters #30-#32.		
Objective 12	Illustrate the locations of various types of information that can be found on an aircraft drawing. Refer to Figure 1-24 in EA-ITP-G 4:I:16-18. Provide additional drawings from various companies to illustrate common items on all drawings.		
Objective 13	Use a scale model airplane to pinpoint the various applications of coordinates such as water line, buttock line, coordinates and station line. Explain how a wing station line is similar to a station line is similar to a station line.		
Objective 14	Gather basic information about students in class to construct a weight and height graph. Refer to EA-ITP-G 4:I:24, 25 for further information about graphs. Stress that graphs are quick visual ways of representing a lot of data in a very brief document.		
Objective 15	Perform basic geometric exercises using Workbook Supplements #17-#21. Stress the importance of being able to make repair sketches and simple layouts of parts.		
Objective 16	Select several blueprints from EA-ITP-G 4:I:1-10 and other sources to prepare basic blueprint reading questions to allow students to be familiar with a variety of aircraft blueprints.		

INSTRUCTIONAL SUPPLEMENT #1--Multi-View Orthographic Drawings and the Folding Box

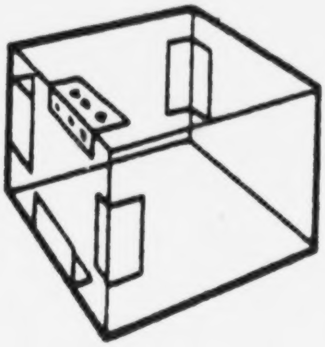
To understand how these views are obtained you must imagine the object to be drawn as being enclosed in a glass box. You, the observer, are on the outside looking in, shifting your position around the box to obtain the various views. Since the glass box has six sides, six normal views could be obtained.



From Basic Mechanical Blueprint Reading, copyright 1983.

INSTRUCTIONAL SUPPLEMENT #1

Since these views are to be shown on a flat sheet of paper, the box must be hinged, so the sides may be folded out placing all the views on one plane. Also to present the views in a standard arrangement, the box must be hinged in the following manner:



All sides except the rear must be hinged
upon the front, and the rear is hinged upon
the right side.

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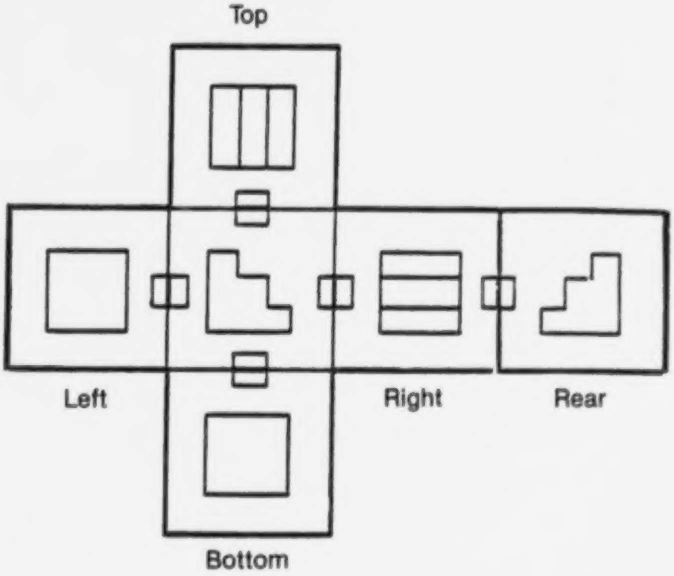
INSTRUCTIONAL SUPPLEMENT #1

When we unfold the box from its original position, the views would appear on paper as shown.


Top
Left
Right
Rear
Bottom

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TECHNICAL INFORMATION SUPPLEMENT #1--Terms and Definitions

A. Detail drawing--Drawing of a single part, drawn to scale with all dimensions and details necessary to make the part in the shop

(NOTE: The drawing number becomes the part number.)

B. Assembly drawing--Drawing that references detail parts by part numbers and specifies types and number of fasteners to be used to join them into subassemblies; includes only those dimensions needed for assembly

C. Installation drawing--Drawing that shows how parts or subassemblies are installed on aircraft, including information on fasteners, adjacent parts, or adjustments

D. Sectional drawing--Drawing that shows internal construction or shape of a part by means of a cross section, half section, revolved, or removed part

E. Exploded-view--Drawing that shows all parts in an assembly in their relative positions, but expanded outward so that each can be identified

F. Block diagram--Diagram showing blocks representing many components, designed to show operations rather than individual parts

(NOTE: A block diagram is used as an aid in troubleshooting.)

G. Logic flowchart--Directs troubleshooting steps in a logical, step-by-step manner, identifying probable faults in a system and specifying repair for each one

H. Electrical wiring diagram--Diagram that identifies all wires, components, and uses of wires in a circuit

I. Pictorial electrical diagram--Diagram of an electrical or hydraulic system using line drawings of components rather than conventional symbols; used to help visualize operation of a system

J. Schematic diagram--Diagram used to explain a principle of operation rather than to show components as they actually appear

K. Orthographic drawing--Drawing composed of up to six views of an object as they would appear if projected onto the surfaces of a transparent box enclosing the object; usually depicts one, two, or three views

L. Isometric drawing--Projection of a three-dimensional object onto a flat plane, with the object rotated so that three of its faces are visible and the angles between each of the sides are equal

M. Oblique drawing--Projection of a three-dimensional object onto a flat plane, with the object rotated so that three of its faces are visible, with one face parallel to the plane of the drawing

N. Perspective drawing--Drawing in which rays projecting from the object intersect at a vanishing point on the horizon

O. Visible lines--Medium-weight solid lines that show edges that are seen in the view of a part

P. Hidden lines--Medium-weight dashed lines that show edges that cannot be seen in the view of a part

Q. Center lines--Alternate long- and short-dashed lines that show centers of holes or of symmetrical parts

R. Dimension lines--Light solid lines used to show exact locations of dimensions, with arrowheads at each end and broken in the center for dimension to be inserted

S. Extension lines--Light lines extending from edges of points at which measurements are made

T. Cutting-plane line--Medium or heavyweight dashed line used to show the plane at which a sectional view is constructed; arrowheads show directions in which the view is seen

U. Phantom lines--Light lines made up of long dashes alternating with two short dashes; used to indicate presence of another part included for reference only, or for alternate position of a part

V. Break lines--Lines used across a dimension of a part which continues but is of no concern in that particular drawing

W. Leader lines--Light lines, with arrowheads, that extend from a note to a part of the drawing to which the note applies

X. Section lines--Lines used to indicate a cross-section, to denote material of which a part is made, or to distinguish between pieces of material

Y. Dimensioning--Indication of precise measurements on a drawing with reference to datum edges or surfaces

Z. Tolerance--Precision with which a part is to be made

TECHNICAL INFORMATION SUPPLEMENT #1

AA. Title block--Record of all necessary manufacturer's information; printed in lower right-hand corner of every aircraft drawing

BB. Drawing number--Number assigned to drawing of aircraft part; becomes permanent part number

CC. Zones--Portions of a roll-size aircraft drawing indicated by letters along the vertical edges and numbers along the horizontal edges

DD. Fuselage stations--Locations fore and aft along the fuselage of an aircraft; measured from a datum called station zero

EE. Water lines--Vertical measurements made on an aircraft with reference to a line called water line zero

FF. Buttock lines--Indication, in inches, of distances to the right or left of centerline of fuselage

GG. Wing stations--Indication, in inches, of distances from fuselage centerline outward along the wing toward the tip

HH. Repair sketch--Sketch that shows location of a repair, types of materials used, and enough detail so repair can be duplicated

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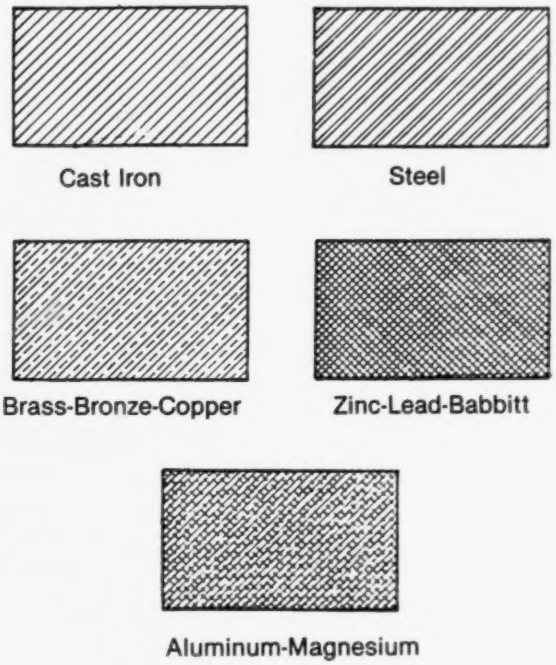
TECHNICAL INFORMATION SUPPLEMENT #2--Types of Sectional Views

Sectional views are used in many ways to illustrate the sizes and shapes of objects as they appear from a variety of positions. There are several types of sectional views, and it is important that the aviation maintenance technician know how to read and interpret information given.

A. Different types of materials shown in sections are represented with a variety of crosshatched lines to symbolize specific materials (Figure 1)

FIGURE 1

Material Symbols in Section



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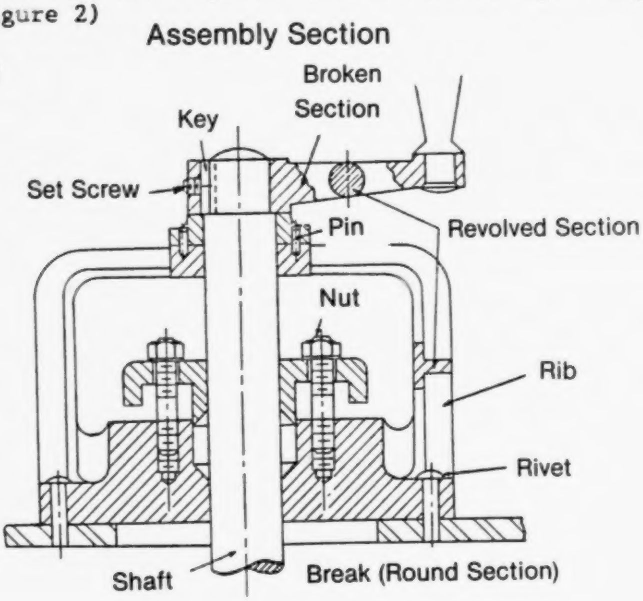
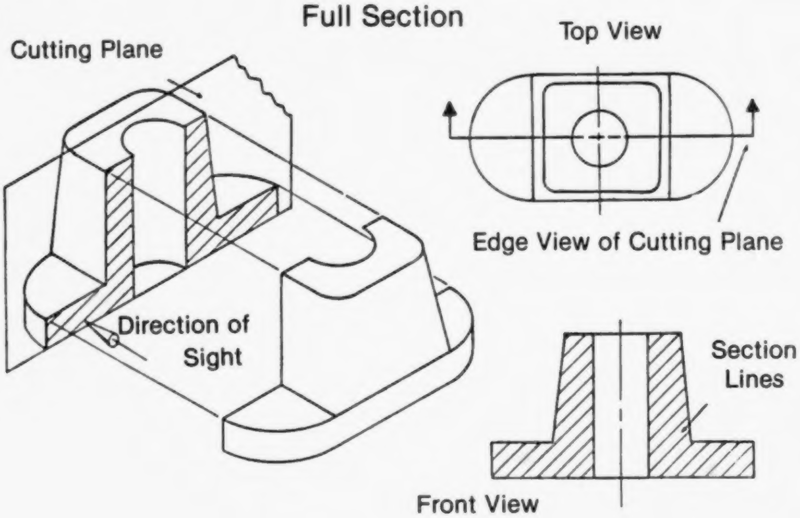
B. When several parts are put together in the form of an assembly drawing, those different parts are indicated by using various material symbols (Figure 2)

FIGURE 2


Assembly Section
Broken Section
Key
Set Screw
Pin
Revolved Section
Nut
Rib
Rivet
Shaft
Break (Round Section)

C. A full section of a part is used when it is necessary to show the entire inside of a part (Figure 3)

FIGURE 3

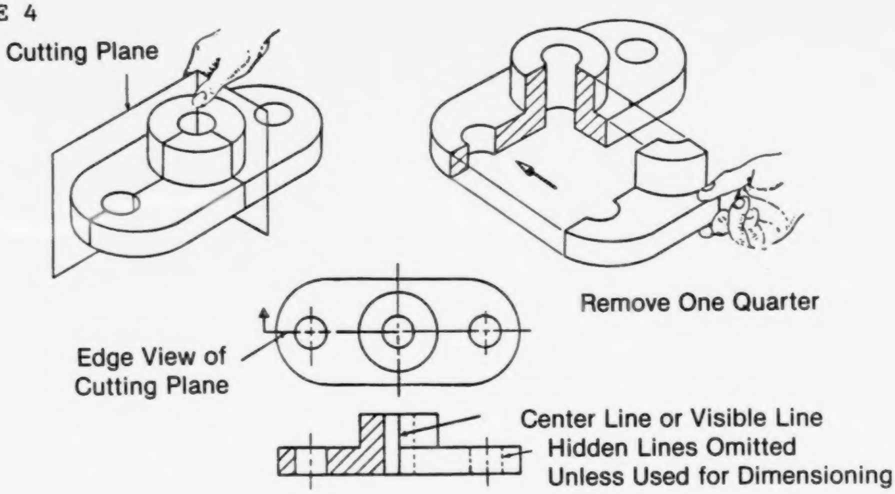

Full Section
Cutting Plane
Top View
Edge View of Cutting Plane
Direction of Sight
Section Lines
Front View

Figures 2 and 3 used with permission of the Mid-America Vocational Curriculum Consortium, from Basic Drafting, Book Two, 1981.

D. A half section is shown when it is necessary to show only half of the object in a section and the other half as the exterior surface of the part (Figure 4)

Half Section

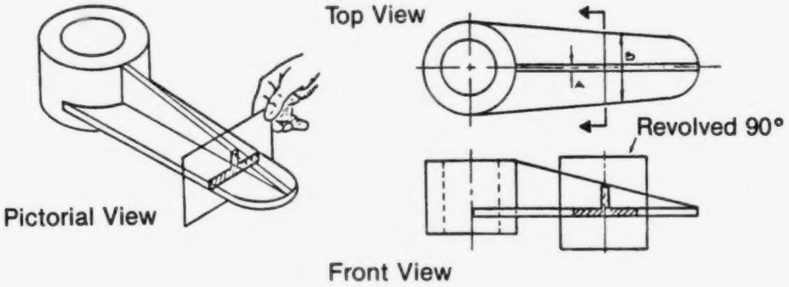
FIGURE 4


Cutting Plane
Remove One Quarter
Edge View of Cutting Plane
Center Line or Visible Line
Hidden Lines Omitted Unless Used for Dimensioning

E. A revolved section is used to show what a portion of the part would look like if it were revolved 90 degrees in one of the views; revolved sections are used quite frequently to eliminate the need for additional views (Figure 5)

FIGURE 5

Revolved Section

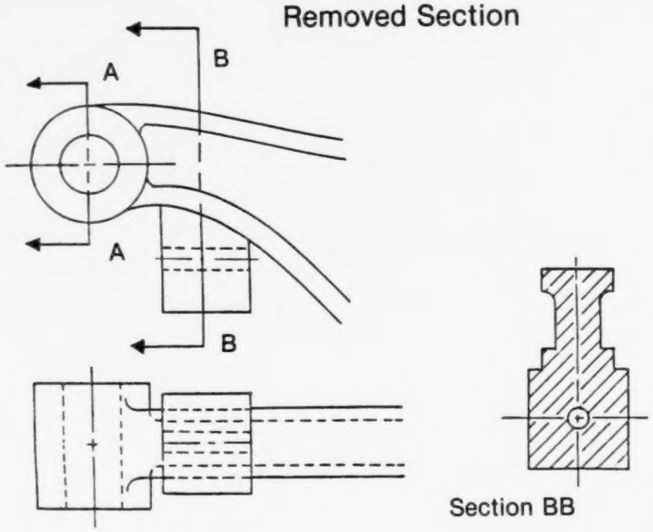

Top View
Revolved 90°
Pictorial View
Front View

Figures 4 and 5 used with permission of the Mid-America Vocational Curriculum Consortium, from Basic Drafting, Book Two, 1981.

F. Removed sections are used to show what a part would look like if an imaginary plane were to cut through an area and show that view in a removed location; removed sections are used to illustrate many different types of parts of the aircraft (Figure 6)

FIGURE 6

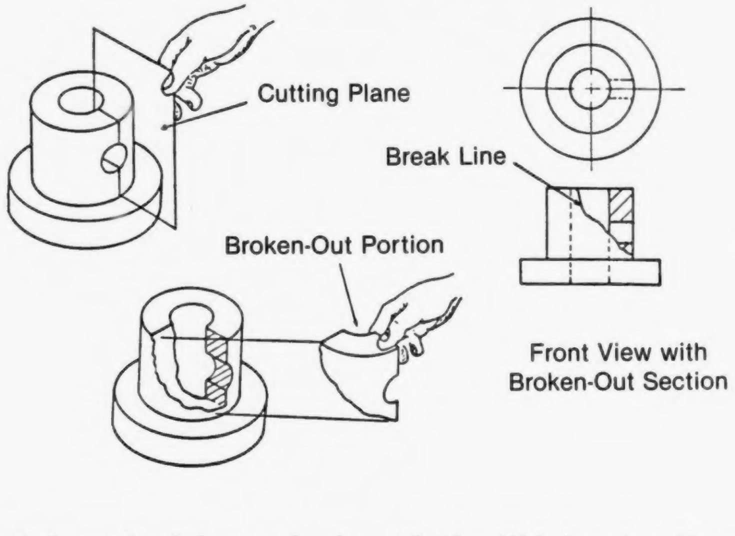
Removed Section


B
A
A
B
Section BB

G. Another very common section is the broken-out section which is used to show only a small portion or area of a part; it is as if you were to break out a portion of an object and show the inside area (Figure 7)

FIGURE 7

Broken-Out Section


Cutting Plane
Break Line
Broken-Out Portion
Front View with
Broken-Out Section

Figures 6 and 7 used with permission of the Mid-America Vocational Curriculum Consortium, from Basic Drafting, Book Two, 1981.

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
G102-C

TECHNICAL INFORMATION SUPPLEMENT #3--Types of Lines Commonly Found on Blueprints

Each line in the drawing has a distinct meaning, depending on how it is used. Learn each line and its use. This will aid in blueprint interpretation. The visible outline is used to define the periphery of a part or assembly. The short dash lines are called hidden lines because they show surfaces that are hidden from view.

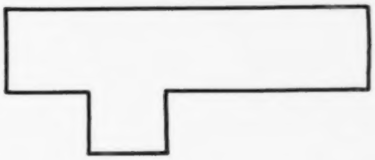
There are two lines that are used which have more than one meaning. The first one is a center line, and is also used to show line of motion. The second multipurpose line is used to show a phantom part, lofted surface, heel line, or an alternate position of a part.

The cutting plane line is used when the interiors of a part cannot be shown clearly by means of hidden lines. The broken line is used when only a partial section of a view is needed to define the part. The ditto line is used to reduce work in drawing springs. A general note usually is shown with the ditto lines or in the separate parts list. The ditto lines can also be seen as stitch lines on insulation or upholstery drawings.

The line conventions shown in this technical information supplement are used by most, if not all, countries.

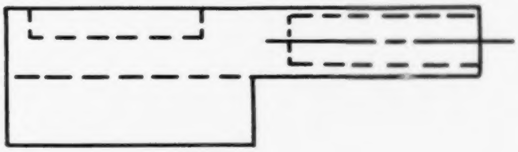
A. Visible line--A heavy, solid line that outlines all the visible lines of the part; indicates the true outline of the part (Figure 8)

FIGURE 8



B. Hidden line--Invisible or hidden surfaces are always shown by a short, dashed line of medium weight; a dashed line always represents a surface that is not visible in that view (Figure 9)

FIGURE 9



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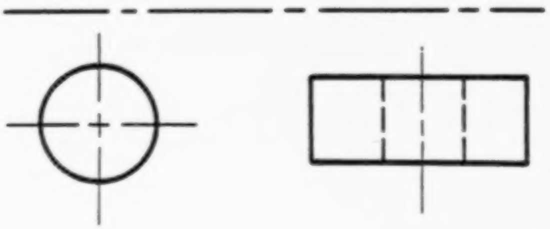
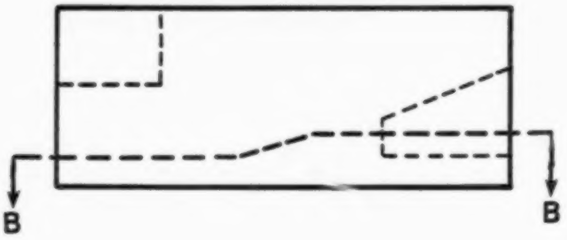
C. Center lines--Thin lines made up of long and short dashes alternately spaced and consistent in length; used to indicate symmetry about an axis and location of centers or to indicate travel of a center in motion (Figure 10)

FIGURE 10



D. Cutting plane line--A dashed line with a short solid line at right angles at each end, with arrowheads; visualize the part at the cutting plane line as if the part were cut through, then look at the cross section in the direction of the arrows (Figure 11)

FIGURE 11



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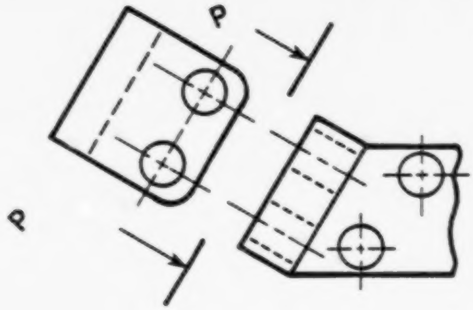
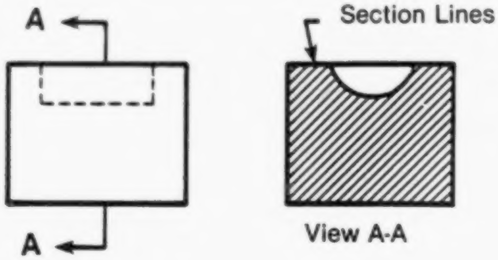
E. Viewing plane--A heavy, solid line with a break in the center and arrowheads at the ends; visualize the part as it would appear from a distance and viewed in the direction of the arrow (Figure 12)

FIGURE 12



F. Section lines--When it is necessary to show a section of a part, a cutting plane line is placed at the point where the section is desired and a view of that section is placed on the drawing; in this view, section lines are used to indicate the exposed cut section of the material (Figure 13)

FIGURE 13



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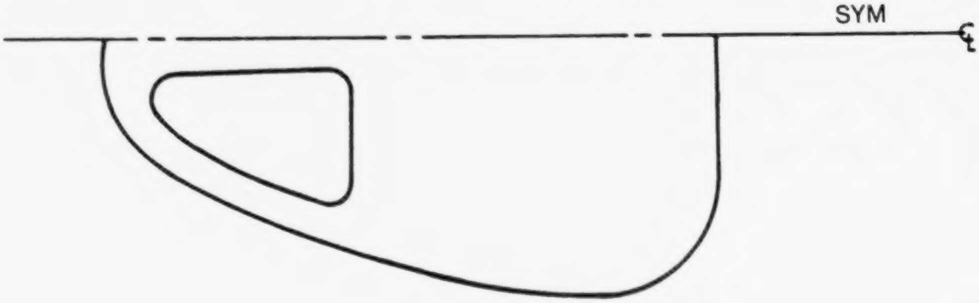
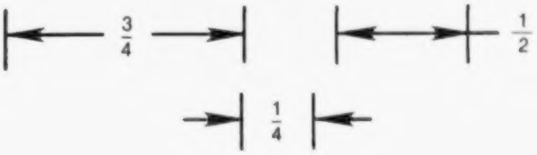
G. Symmetrical center line--The symmetrical center line is constructed in the same manner as the center line with addition of the letters "SYM" and "C_L"; this indicates that even though one side is not drawn, both the dimensions and part shape are identical on either side of the center line (Figure 14)

FIGURE 14



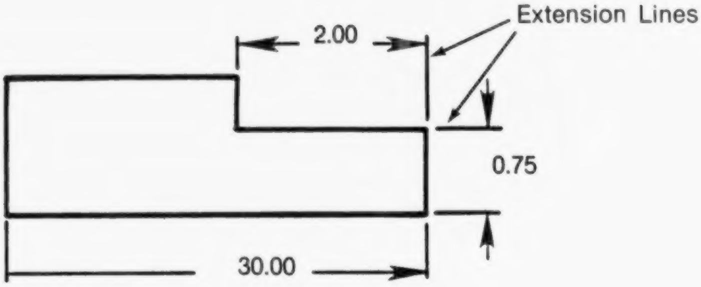
H. Dimension lines--Dimension lines lie between extension lines and have an arrowhead at each end, with a space in the center for the actual dimension; when small dimensions are used, the dimension lines may be shown outside the extension lines (Figure 15)

FIGURE 15



I. Extension lines--Light, solid lines extending from the surface of which the dimension is being shown (Figure 16)

FIGURE 16



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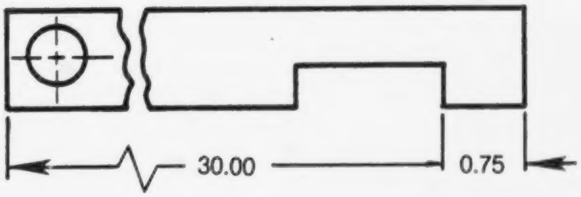
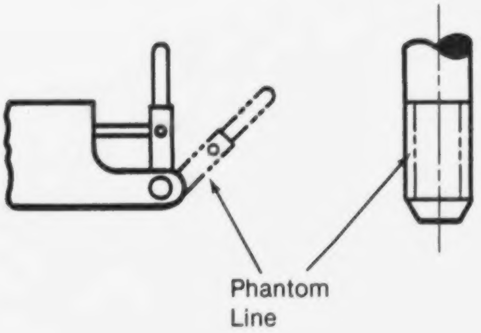
J. Confined dimension--Used when position to reference line is blocked by other dimensions or parts; also used to show a dimension across a broken material area on the drawings (Figure 17)

FIGURE 17



K. Phantom or reference line--Indicates parts shown in reference only, such as absent parts, alternate positions, machine allowance, and threads; consists of one long and two short, uniform, evenly spaced dashes (Figure 18)

FIGURE 18



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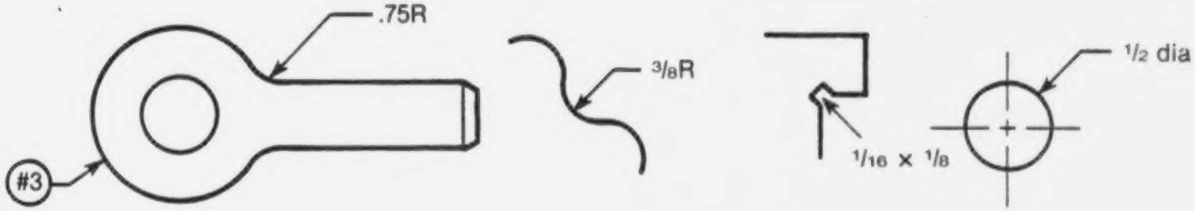
L. Leader line--Used to indicate the drawing area to which a callout applies (Figure 19)

FIGURE 19



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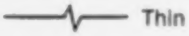
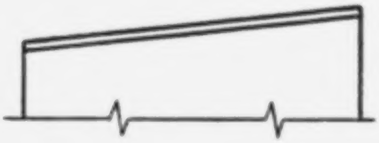
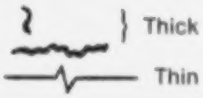
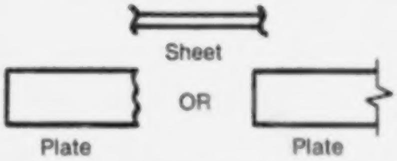
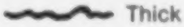
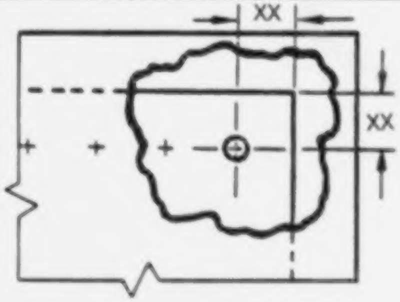
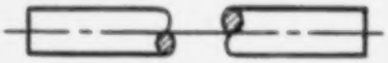
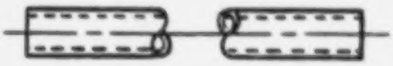
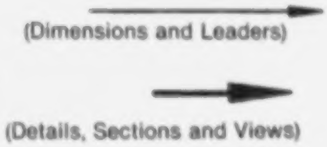
TECHNICAL INFORMATION SUPPLEMENT #3

Break Lines

BREAK INDICATORS	Long Break	Large parts.  	
	Short Break	 	 Sheet OR Plate Plate
	Breakaway	Breakaway for access to solid lines.  	
	Cylindrical	Solid	
		Tube, Pipe, Etc.	
Arrowhead		Designates line or object intended for callout. Head length approximately three times the width. Length should not vary on any one drawing, except that arrows for Details, Sections, and Views are made extra large.	 (Dimensions and Leaders) (Details, Sections and Views)

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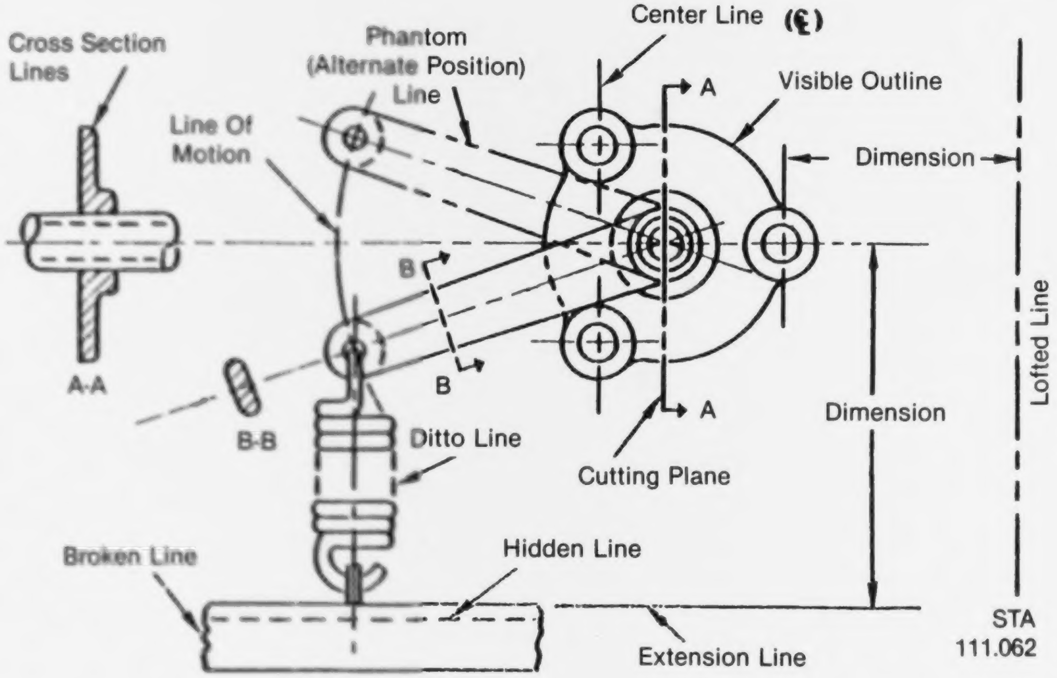
Universal Language of Lines

Type of Line	Example
Visible Outline	────────────
Hidden Line	– – – – – – – – – –
CL, Line of Motion	──────── – ────
Dimension & Extension	|←────────→|
Phantom, Lofted, & Heel Line	─────── – – ───────
Cutting Plane	↑── ── ── ──↑
Alternate Position	─────── – – ───────
Broken Line	⌒── OR ─^───^──
Ditto Line	–– –– –– –– –– ––


Cross Section Lines
Phantom (Alternate Position) Line
Center Line (℄)
Line Of Motion
A
Visible Outline
Dimension
B
B
A-A
B-B
Ditto Line
A
Cutting Plane
Dimension
Lofted Line
Broken Line
Hidden Line
Extension Line
STA 111.062

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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
G102-C

TECHNICAL INFORMATION SUPPLEMENT #4--Tolerancing

Industry, until recent times, was under the assumption that the parts they were manufacturing were being made to exact sizes. When more accurate measuring tools were developed it was found that their "exact sizes" had deviations of size in them. It was found that these slight variations were acceptable because they did not affect the function and operation of the parts themselves or in an assembly. Industry also found that under certain applications the exact sizes being held were not necessary. By providing a definite set of limits (tolerances) to a dimension, the mechanic and technician could control the size between these limits and still supply industry with sufficient accuracy. It is also important to note that industries do not necessarily manufacture all of the parts that go into the product they sell. These parts are made by smaller companies who specialize in various types of manufacturing. They are known as **job shops**. The way in which these major industries communicate how they want their parts made is through the use of the blueprint. Blueprints not only show shape and size of a part to be manufactured, but must include size limitations to ensure that these parts will meet the specifications that the engineering department requires. They must function and fit into their assemblies according to the specification.

Obviously, these specifications and tolerances must also be met by the major industries themselves.

In the study of this section there are various terms and symbols that must be learned and understood in order to be able to fully interpret this area of engineering drawings. Note that as you read these terms, they are listed in a sequence that engineering and design use for applying the tolerance permitted on a part.

The following are the terms most frequently encountered in industry relating to tolerancing.

Nominal Size

The term nominal means **name**, so the purpose of having a nominal size is to name or identify the size of the object. This size normally does not appear on the print, but is used to verbally express the size or a feature of an object. When an industry uses the term nominal size, they may be referring to a size assigned to a consumer product that may or may not be the actual size of that product.

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TECHNICAL INFORMATION SUPPLEMENT #4

Allowance

This is the intentional difference or space between the size of the parts that are to fit or mate together. There are two classifications of fit. One is **clearance fit**, in which the internal part is intentionally made smaller than the external part, as illustrated in Fig. 3-8. The other is an **interference fit**, in which the internal part is intentionally made larger than the external part, as in Fig. 3-9. Interference fit parts are then either force fitted together or thermal fitted together.

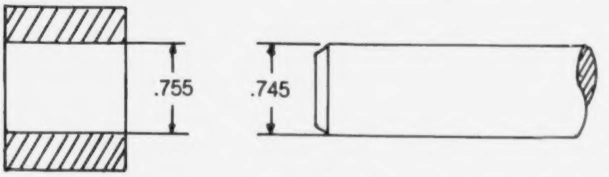

Figure 3-8 Example of a clearance fit. The shaft is .010 smaller than the hole.

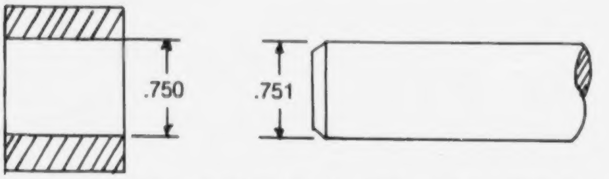

Figure 3-9 Example of an interference fit. The shaft is .001 larger than the hole.

Basic Size

It is from this size that engineering and design have determined that with proper tolerances and allowances the part will fit, according to how it was designed. There are two basic dimensioning systems used.

The basic hole system is one in which the designer or engineer has determined the necessary hole size and the allowance is then related to the shaft. If, for example, an engineer determines that a hole is designed to be .750", an allowance is applied to this hole in the plus direction to be sure the hole is produced no less than .750". See Fig. 3-10(a). The shaft is then given a designed size of .749" by the engineer, .001" less than the designed hole size to ensure a clearance fit. See Fig. 3-10(b). An allowance must be applied to the shaft size to provide a tolerance of, say, ± .002" for variance in manufacturing, as shown in Fig. 3-10(c).

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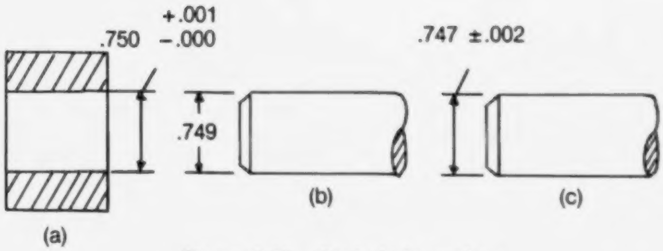

Figure 3-10 Basic hole system.

The **basic shaft system** is the other system used by engineers and designers, but in this system the shaft size is the designed size and the allowances are applied to the hole. See Fig. 3-11. For example, if an engineer determined a shaft is designed to be .750" in size, an allowance is applied to this shaft in the minus direction to be sure the shaft is produced no larger than .750", as in Fig. 3-11(a). The hole is then given a designed size of .751" by the engineer, .001" more than the designed shaft size to ensure a clearance fit, as in Fig. 3-11(b). An allowance must then be applied to the hole to produce a tolerance of, say, ± .002" for variance in manufacturing, as in Fig. 3-11(c).

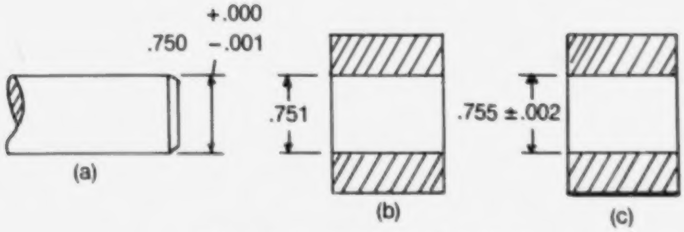

Figure 3-11 Basic shaft system.

Actual Size

The size accurately measured.

Limits of Size

The extreme limits permitted on a part are the maximum and minimum sizes. The limits of size in Fig. 3-10(c) are .745" to .749" due to the tolerance of ± .002".

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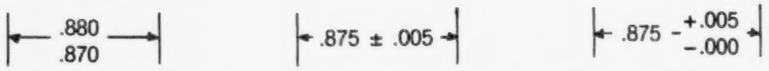
TECHNICAL INFORMATION SUPPLEMENT #4

Tolerance

The total permitted variation from the design size of a part is known as the tolerance. The tolerance is the difference between the limit sizes and should always be as large as possible according to the design to reduce manufacturing costs. Generally the closer the tolerances, the higher the cost of manufacturing.

There are various ways of expressing the tolerance permitted on a dimension.



(a) Limit dimension (b) Bilateral tolerance (c) Unilateral tolerance

Figure 3-12 The various ways of expressing tolerances on an engineering drawing

Limit Dimensions

There are always two dimensions shown on a print or a specific feature when limit dimensions are assigned: the maximum permitted size and the minimum permitted size. Within these two dimensions is the included allowable tolerance for that size, as in Fig. 3-12(a).

Bilateral Tolerance

This is a tolerance that permits variation of plus or minus in both directions from the design size, as in Fig. 3-12(b).

Unilateral Tolerance

This is a tolerance that permits variations in only one direction, either positive (plus) or negative (minus) from the design size, as in Fig. 3-12(c).

In both bilateral and unilateral tolerancing systems, the design size is given on the blueprint first and then followed directly to the right with the tolerances, as in Fig. 3-12(b) and (c).

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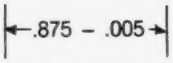
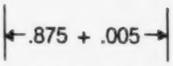
If only one tolerance value is given, it is assumed that the other value is zero. See Fig. 3-13.



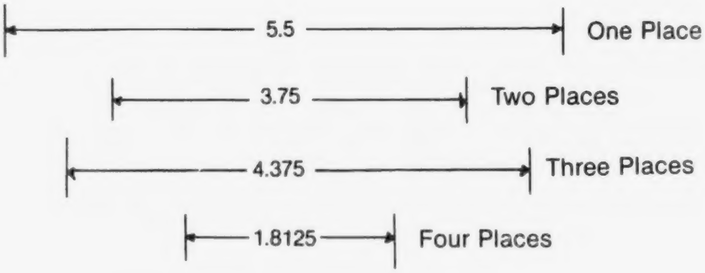
(a) Minus tolerance is zero



(b) Plus tolerance is zero

Figure 3-13 Tolerance representation when only a plus or minus tolerance is given.

When tolerance does not appear next to the size or there are no limit dimensions given (just one dimension), these dimensions then have a **standard** tolerance. It is understood that the tolerance is then found in the **tolerance block** in the title block area. The tolerance is then determined by how many decimal places are shown. See Fig. 3-14.



Tolerances unless otherwise stated		
One place	.0	±.030
Two place	.00	±.015
Three place	.000	±.005
Four place	.0000	±.0005
Angles	∡	±0° 30′

Figure 3-14 Tolerance block.

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Another way of expressing a tolerance is to give a dimension without a tolerance of either plus or minus. In its place the letters MIN (minimum size) are given, meaning that the size of the object at that dimension cannot be less than the dimension given. See Fig. 3-15(a). The opposite is true of a dimension that has the letters MAX after it. MAX stands for maximum. See Fig. 3-15(b). The size of the object at that dimension cannot be larger than the dimension given.

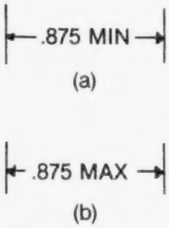

Figure 3-15
Example of expressing tolerances: (a) minimum (MIN); (b) maximum (MAX).

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TECHNICAL INFORMATION SUPPLEMENT #4

Angular Dimension Tolerances

The tolerances for angular dimesions can be given in several ways. The exact size of the angle will appear with the tolerance directly to the right in either a bilateral or unilateral tolerance. See Fig. 3-16(a) and (b). The angle could also appear with limit dimensions [Fig. 3-16(c)] or the tolerance could be obtained from the tolerance block when none appears next to the dimension [Fig. 3-16(d)].

The dimension could also appear without a tolerance, but have the term MAX or MIN after it [Fig. 3-16(e) and (f)].

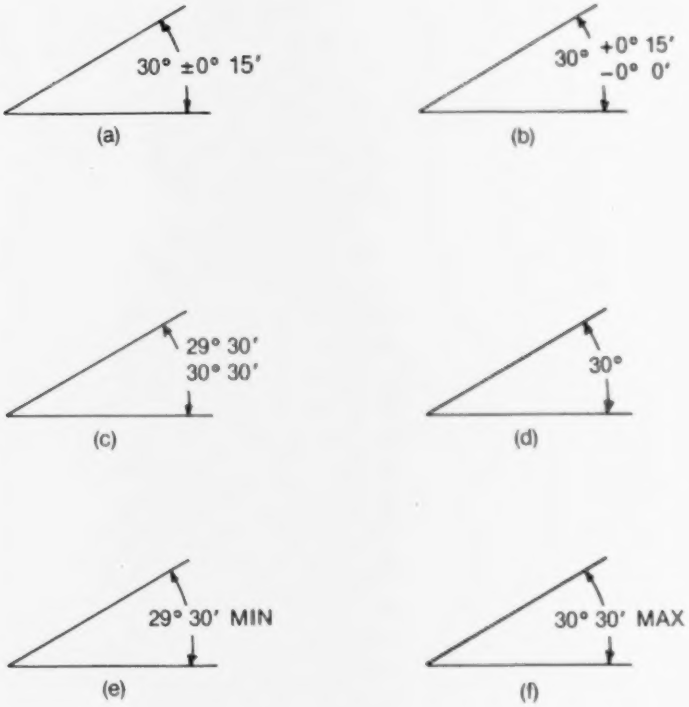

Figure 3-16 The commonly accepted way of indicating tolerances for angular dimensions.

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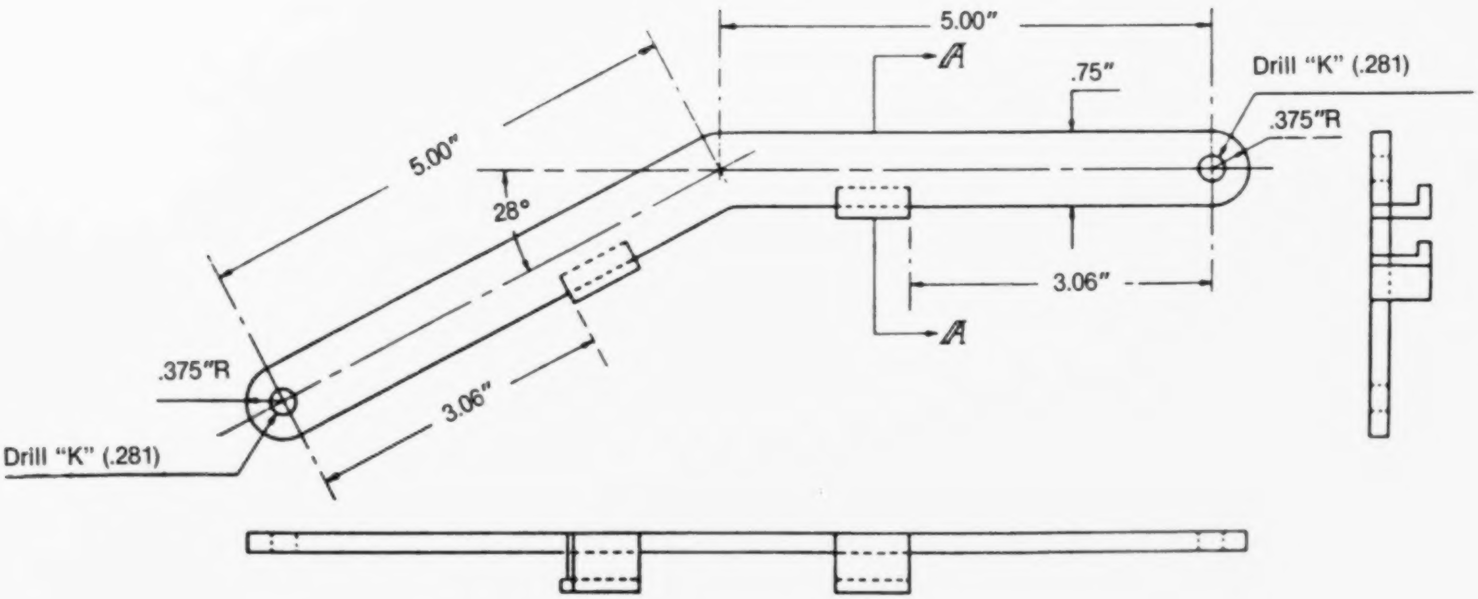
Types Of Aircraft Drawings

Detail Drawing


5.00"
5.00"
A
.75"
Drill "K" (.281)
.375"R
28°
3.06"
A
.375"R
3.06"
Drill "K" (.281)

Material — Steel

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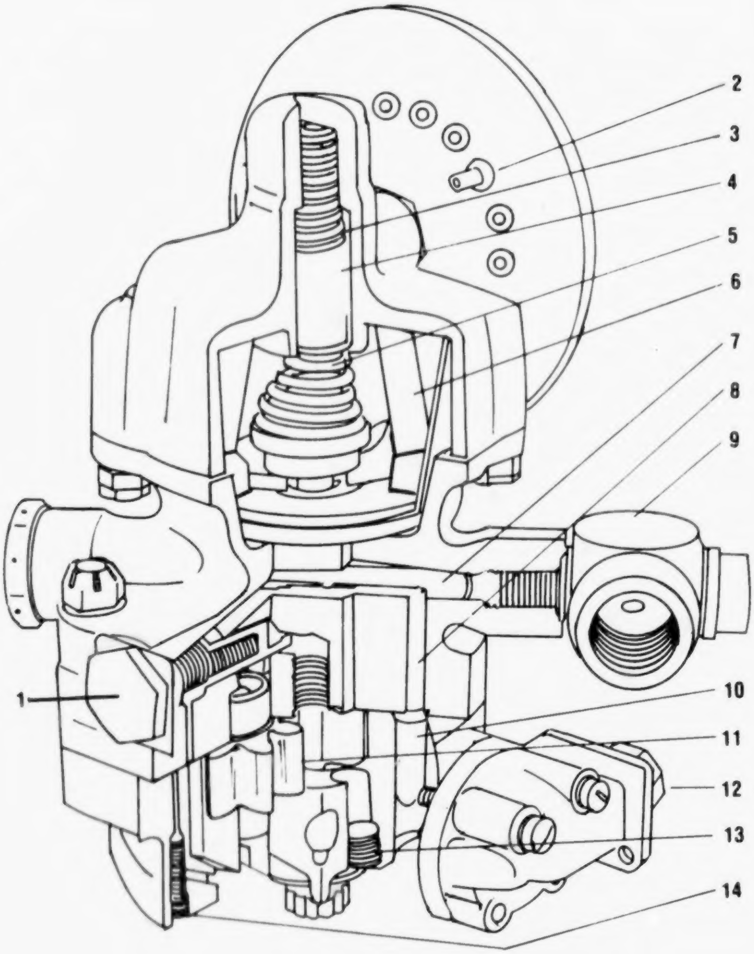
Types of Aircraft Drawings

(Continued)

Assembly Drawing



1. Relief Valve
2. Pulley Stop Pin
3. Balance Spring
4. Rack Assembly
5. Speeder Spring
6. Fly-Weight
7. Transfer Valve Plunger
8. Propeller Oil Passage
9. Swivel Fitting
10. Propeller Oil Strainer
11. Pump Idler Gear
12. Cutout Switch
13. Base Oil Control Plug
14. Dump Valve

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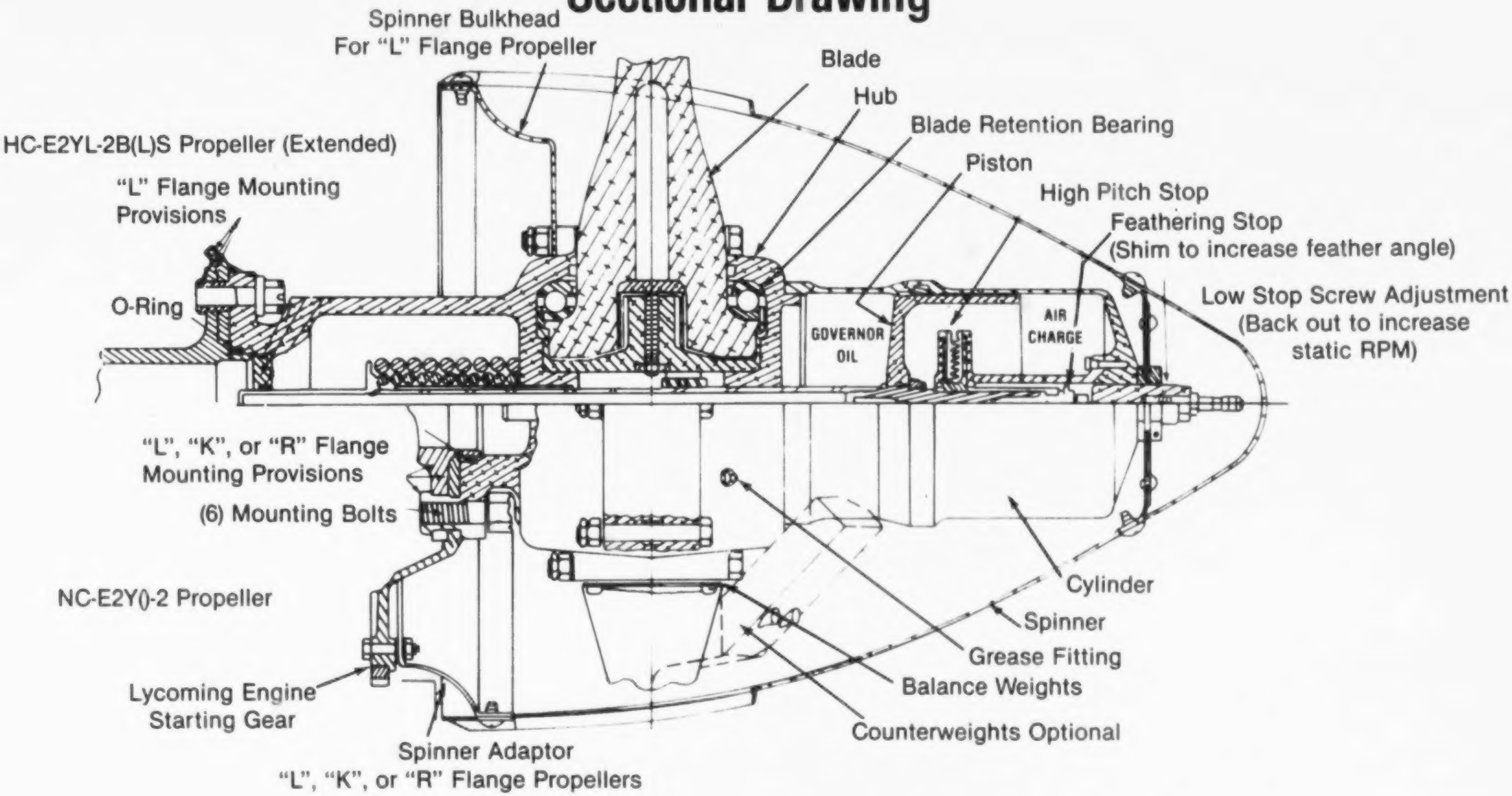
Types of Aircraft Drawings

(Continued)

Sectional Drawing


Spinner Bulkhead
For "L" Flange Propeller
Blade
Hub
Blade Retention Bearing
Piston
High Pitch Stop
Feathering Stop
(Shim to increase feather angle)
Low Stop Screw Adjustment
(Back out to increase
static RPM)
HC-E2YL-2B(L)S Propeller (Extended)
"L" Flange Mounting
Provisions
O-Ring
GOVERNOR
OIL
AIR
CHARGE
"L", "K", or "R" Flange
Mounting Provisions
(6) Mounting Bolts
NC-E2Y()-2 Propeller
Cylinder
Spinner
Grease Fitting
Balance Weights
Counterweights Optional
Lycoming Engine
Starting Gear
Spinner Adaptor
"L", "K", or "R" Flange Propellers

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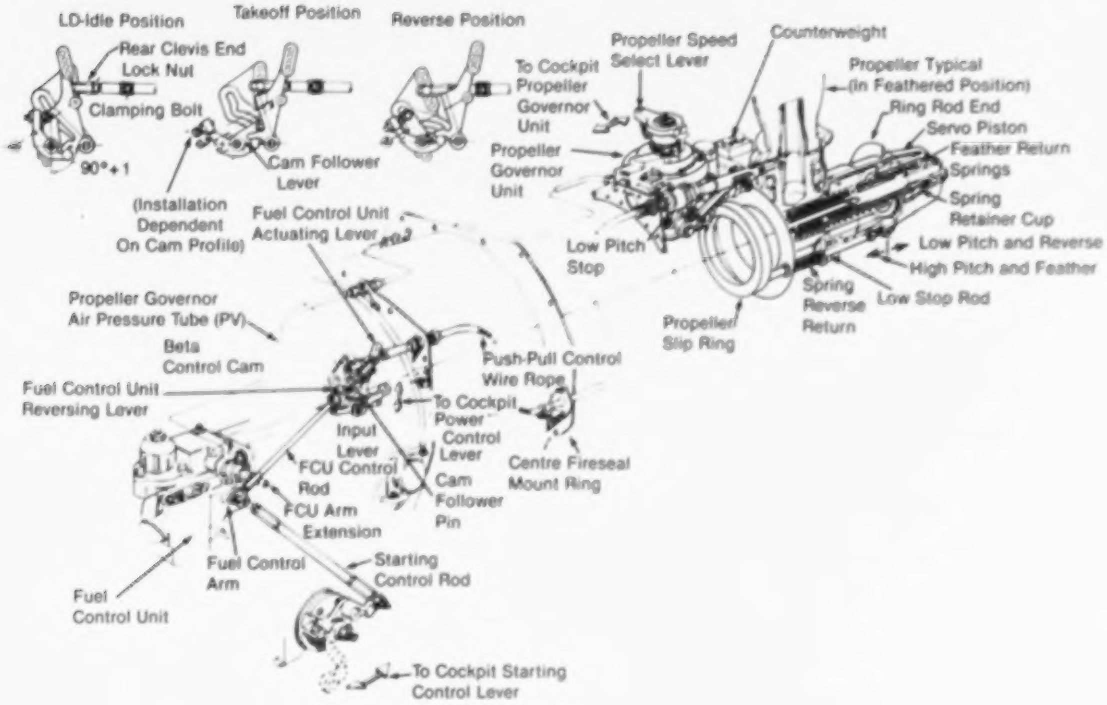
Types of Aircraft Drawings

(Continued)

Installation Drawing


LD-Idle Position
Takeoff Position
Reverse Position
Rear Clevis End Lock Nut
Clamping Bolt
90°+1
Cam Follower Lever
(Installation Dependent On Cam Profile)
To Cockpit Propeller Governor Unit
Propeller Speed Select Lever
Counterweight
Propeller Typical (in Feathered Position)
Ring Rod End
Servo Piston
Feather Return Springs
Spring Retainer Cup
Low Pitch and Reverse
High Pitch and Feather
Low Stop Rod
Spring Reverse Return
Propeller Slip Ring
Low Pitch Stop
Propeller Governor Unit
Fuel Control Unit Actuating Lever
Propeller Governor Air Pressure Tube (PV)
Beta Control Cam
Fuel Control Unit Reversing Lever
Push-Pull Control Wire Rope
To Cockpit Power Control Lever
Centre Fireseal Mount Ring
Input Lever
FCU Control Rod
Cam Follower Pin
FCU Arm Extension
Fuel Control Arm
Starting Control Rod
Fuel Control Unit
To Cockpit Starting Control Lever

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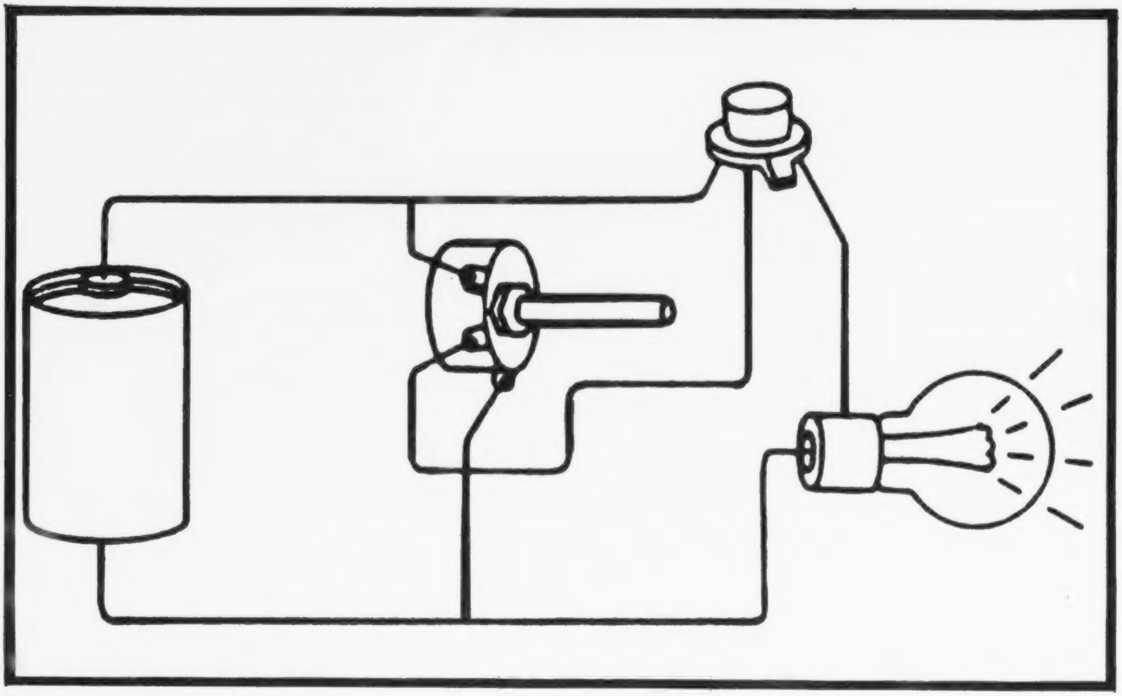
Types of Aircraft Drawings

(Continued)

Pictorial Electrical Diagram



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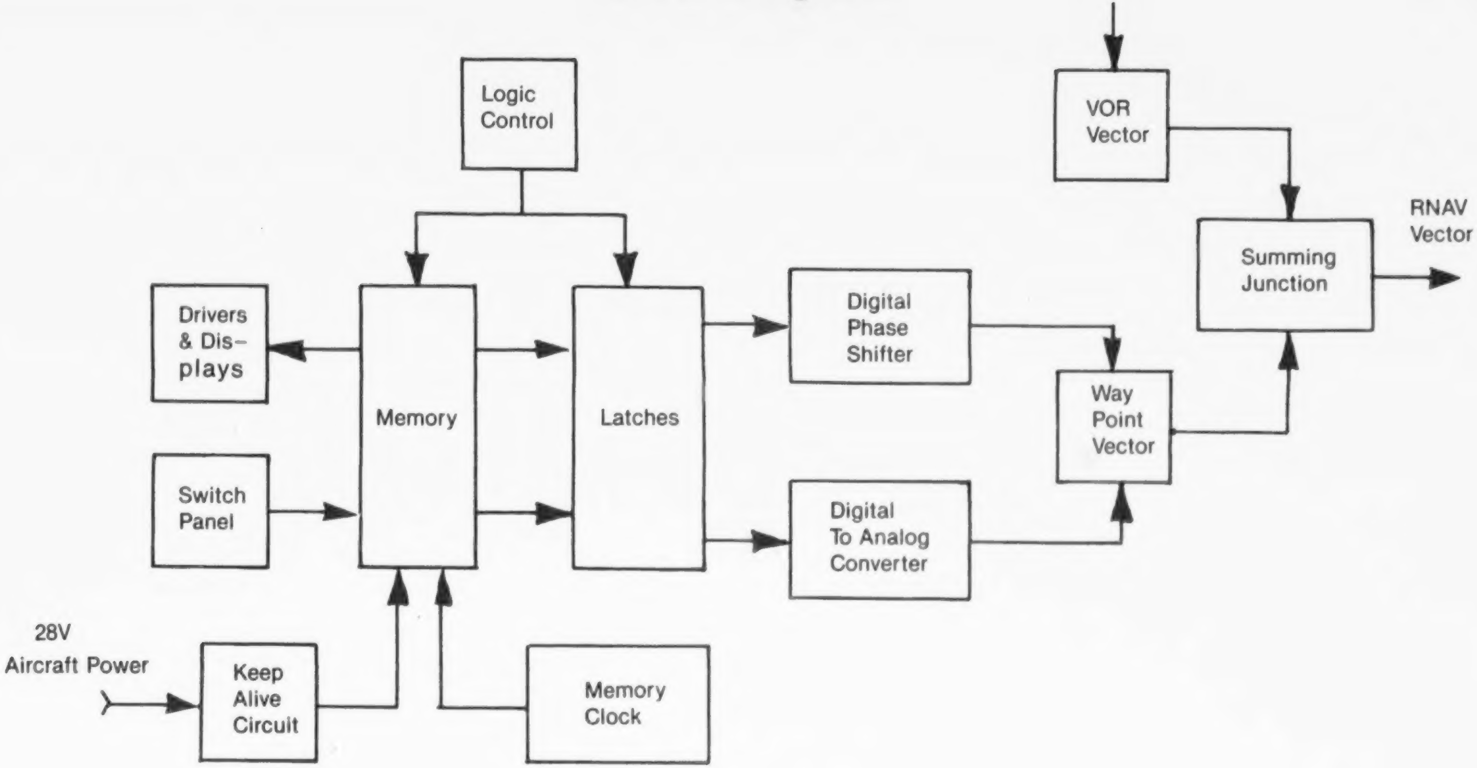
G102C-53

TM #5

Types of Aircraft Drawings

(Continued)

Block Diagram


Logic Control
VOR Vector
RNAV Vector
Summing Junction
Drivers & Displays
Memory
Latches
Digital Phase Shifter
Way Point Vector
Switch Panel
Digital To Analog Converter
28V Aircraft Power
Keep Alive Circuit
Memory Clock

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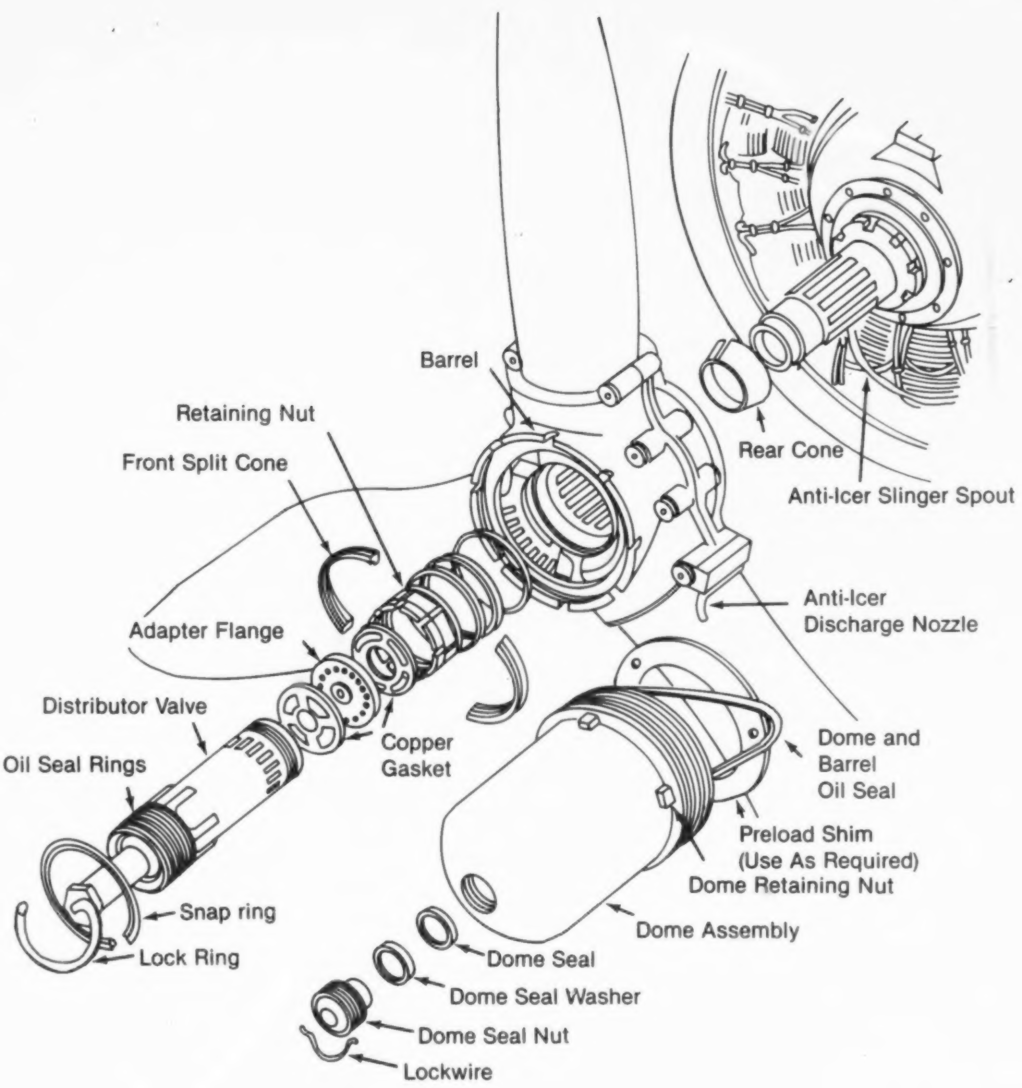
G102C-55

TM #6

Types of Aircraft Drawings
(Continued)
Exploded View Drawing


Barrel
Retaining Nut
Front Split Cone
Adapter Flange
Distributor Valve
Oil Seal Rings
Snap ring
Lock Ring
Copper Gasket
Rear Cone
Anti-Icer Slinger Spout
Anti-Icer Discharge Nozzle
Dome and Barrel Oil Seal
Preload Shim (Use As Required)
Dome Retaining Nut
Dome Assembly
Dome Seal
Dome Seal Washer
Dome Seal Nut
Lockwire

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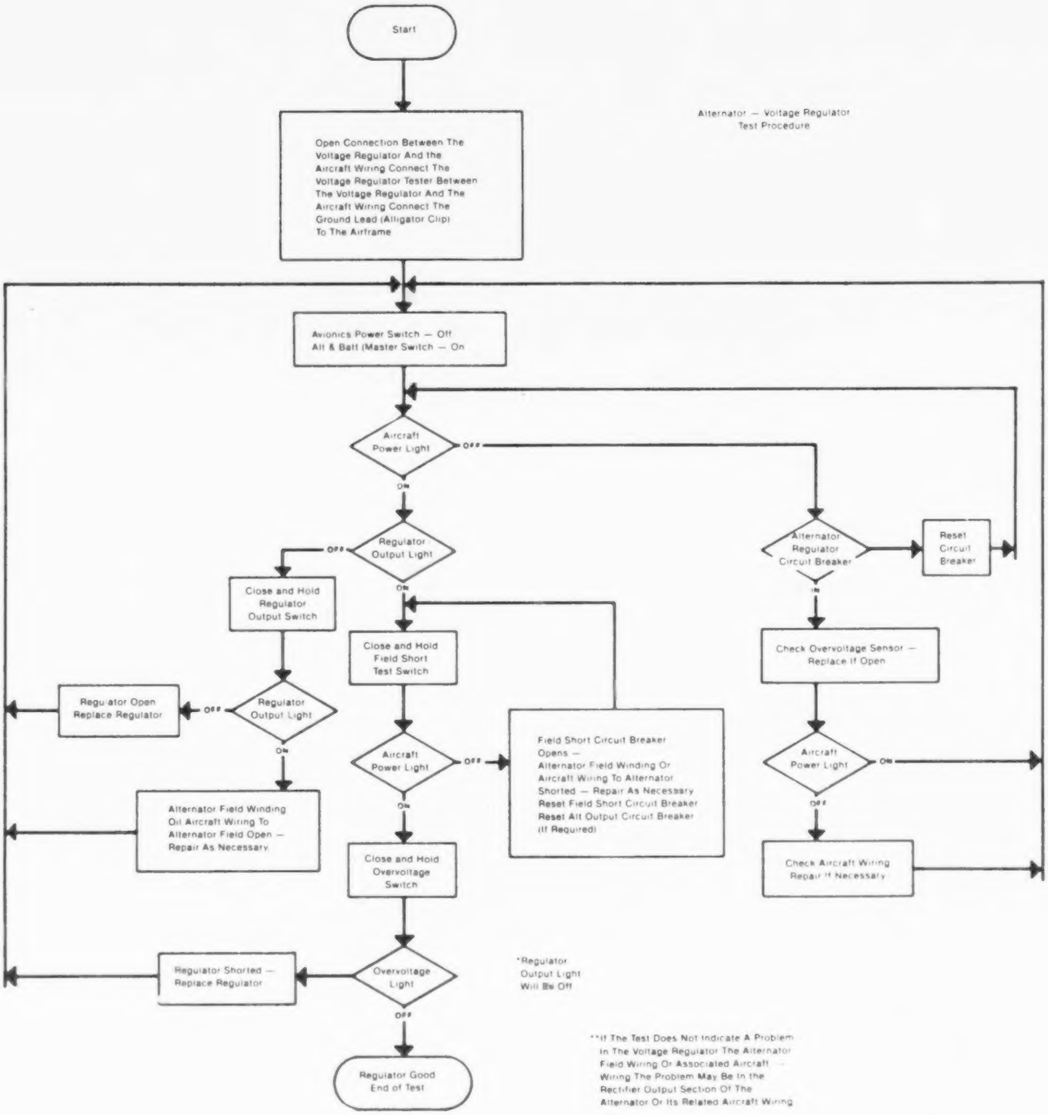
TM #7

Types of Aircraft Drawings

(Continued)

Logic Flowchart


Start
Open Connection Between The Voltage Regulator And the Aircraft Wiring Connect The Voltage Regulator Tester Between The Voltage Regulator And The Aircraft Wiring Connect The Ground Lead (Alligator Clip) To The Airframe
Avionics Power Switch — Off
Alt & Batt (Master Switch — On
Aircraft Power Light
OFF
ON
Regulator Output Light
OFF
ON
Alternator Regulator Circuit Breaker
Reset Circuit Breaker
ON
Close and Hold Regulator Output Switch
Close and Hold Field Short Test Switch
Check Overvoltage Sensor — Replace If Open
Regulator Open Replace Regulator
OFF
Regulator Output Light
ON
Aircraft Power Light
OFF
Field Short Circuit Breaker Opens — Alternator Field Winding Or Aircraft Wiring To Alternator Shorted — Repair As Necessary Reset Field Short Circuit Breaker Reset Alt Output Circuit Breaker (If Required)
Aircraft Power Light
ON
OFF
ON
Alternator Field Winding Oil Aircraft Wiring To Alternator Field Open — Repair As Necessary
Close and Hold Overvoltage Switch
Check Aircraft Wiring Repair If Necessary
Regulator Shorted — Replace Regulator
Overvoltage Light
OFF
Regulator Good End of Test

Alternator — Voltage Regulator
Test Procedure

*Regulator Output Light Will Be Off

**If The Test Does Not Indicate A Problem In The Voltage Regulator The Alternator Field Wiring Or Associated Aircraft — Wiring The Problem May Be In the Rectifier Output Section Of The Alternator Or Its Related Aircraft Wiring

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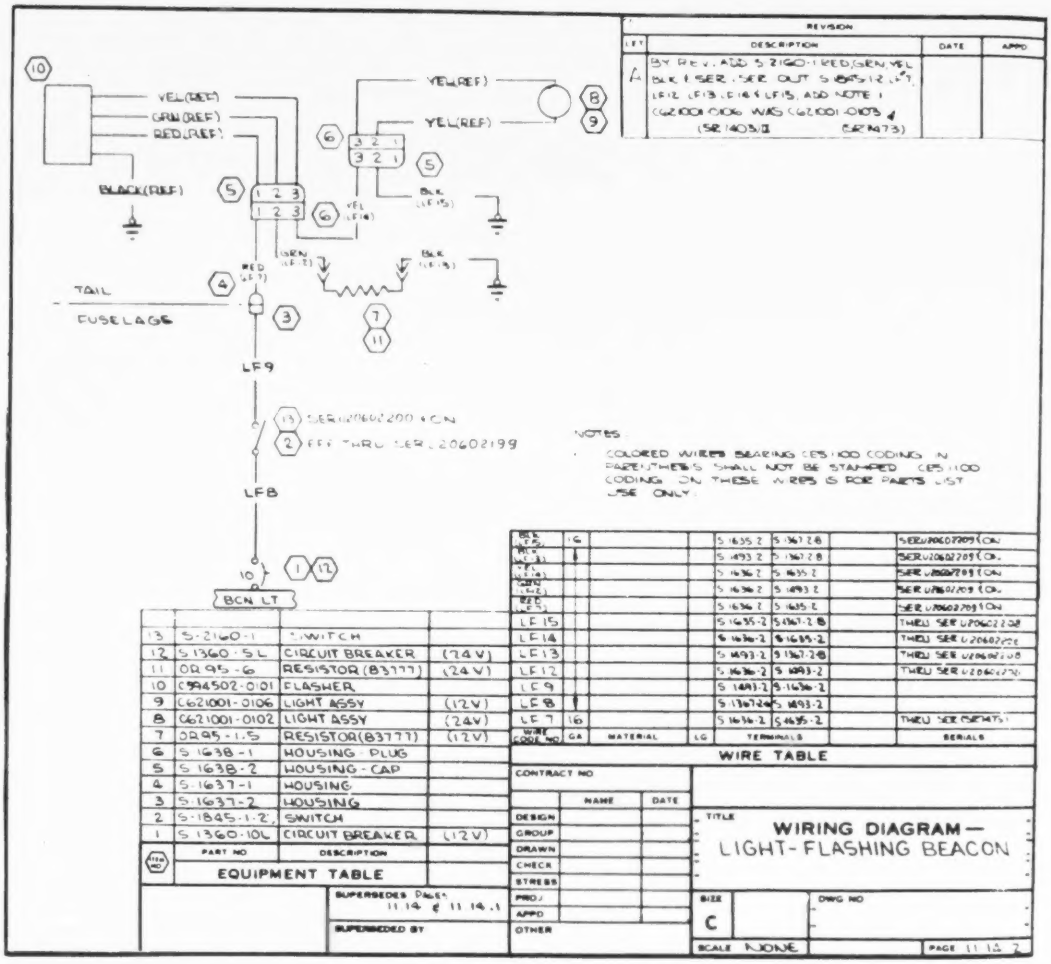
Types of Aircraft Drawings

(Continued)

Electrical Wiring Diagram


10
YEL(REF)
GRN(REF)
RED(REF)
BLACK(REF)
YEL(REF)
YEL(REF)
8
9
6
3 2 1
3 2 1
5
5
1 2 3
1 2 3
6
YEL (LF14)
BLK (LF15)
GRN (LF12)
BLK (LF13)
RED (LF7)
4
TAIL
FUSELAGE
3
7
11
LF9
13 SER U20602200 & ON
2 EFF THRU SER U20602199
LF8
10
1
12
BCN LT

REVISION			
LET	DESCRIPTION	DATE	APPD
A	BY REV. ADD S-2160-1 RED, GRN, YEL BLK & SER. SER OUT S 1845-1-2 LF7, LF12, LF13, LF14 & LF15, ADD NOTE 1 C621001-0106 WAS C621001-0103 & (SR 1403/1) (SR 1473)		

NOTES:

1. COLORED WIRES BEARING CES 1100 CODING IN PARENTHESIS SHALL NOT BE STAMPED. CES 1100 CODING ON THESE WIRES IS FOR PARTS LIST USE ONLY.

WIRE CODE NO	GA	MATERIAL	LG	TERMINALS			SERIALS
BLK (LF15)	16			S 1635-2	S 1367-2-8		SER U20602209 & ON
BLK (LF13)				S 1493-2	S 1367-2-8		SER U20602209 & ON
YEL (LF14)				S 1636-2	S 1635-2		SER U20602209 & ON
GRN (LF12)				S 1636-2	S 1493-2		SER U20602209 & ON
RED (LF7)				S 1636-2	S 1635-2		SER U20602209 & ON
LF 15				S 1635-2	S 1367-2-8		THRU SER U20602208
LF 14				S 1636-2	S 1635-2		THRU SER U20602208
LF 13				S 1493-2	S 1367-2-8		THRU SER U20602208
LF 12				S 1636-2	S 1493-2		THRU SER U20602208
LF 9				S 1493-2	S 1636-2		
LF 8				S 1367-2-4	S 1493-2		
LF 7	16			S 1636-2	S 1635-2		THRU SER (SE1473)

WIRE TABLE

ITEM NO	PART NO	DESCRIPTION	
13	S-2160-1	SWITCH	
12	S 1360-5L	CIRCUIT BREAKER	(24 V)
11	OR 95-6	RESISTOR (83777)	(24 V)
10	C594502-0101	FLASHER	
9	C621001-0106	LIGHT ASSY	(12 V)
8	C621001-0102	LIGHT ASSY	(24 V)
7	OR95-1.5	RESISTOR (83777)	(12 V)
6	S 1638-1	HOUSING-PLUG	
5	S 1638-2	HOUSING-CAP	
4	S-1637-1	HOUSING	
3	S-1637-2	HOUSING	
2	S-1845-1-2	SWITCH	
1	S 1360-10L	CIRCUIT BREAKER	(12 V)

EQUIPMENT TABLE

SUPERSEDES PAGES 11.14 & 11.14.1

SUPERSEDED BY

CONTRACT NO

	NAME	DATE
DESIGN		
GROUP		
DRAWN		
CHECK		
STRESS		
PROJ		
APPD		

OTHER

TITLE WIRING DIAGRAM — LIGHT-FLASHING BEACON

SIZE C

DWG NO

SCALE NONE

PAGE 11.14.2

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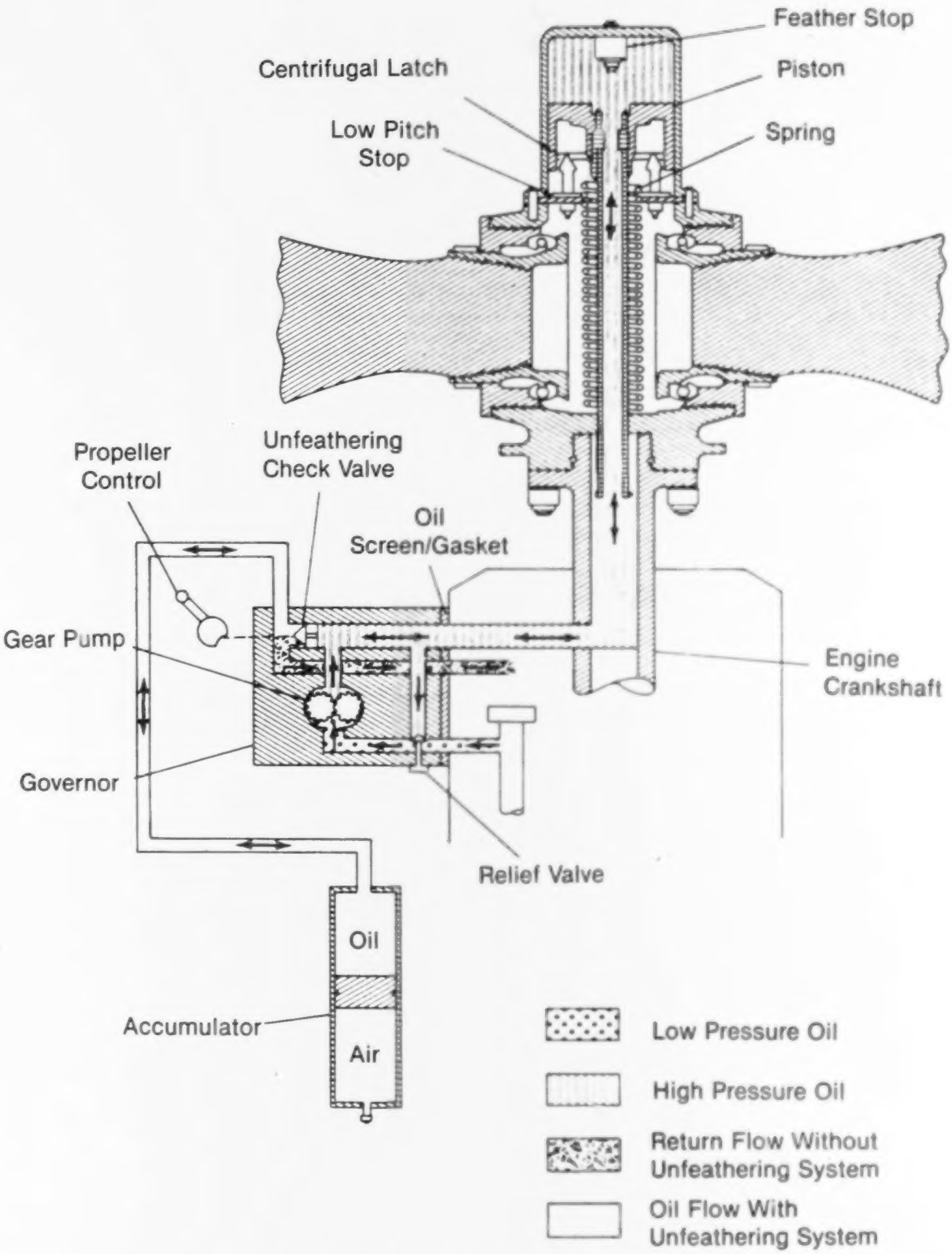
TM #9

Types of Aircraft Drawings

(Continued)

Schematic Diagram


Feather Stop
Centrifugal Latch
Piston
Low Pitch Stop
Spring
Propeller Control
Unfeathering Check Valve
Oil Screen/Gasket
Gear Pump
Engine Crankshaft
Governor
Relief Valve
Oil
Accumulator
Air
Low Pressure Oil
High Pressure Oil
Return Flow Without Unfeathering System
Oil Flow With Unfeathering System

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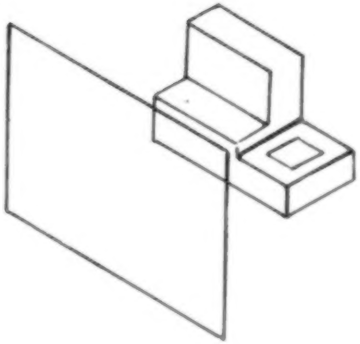
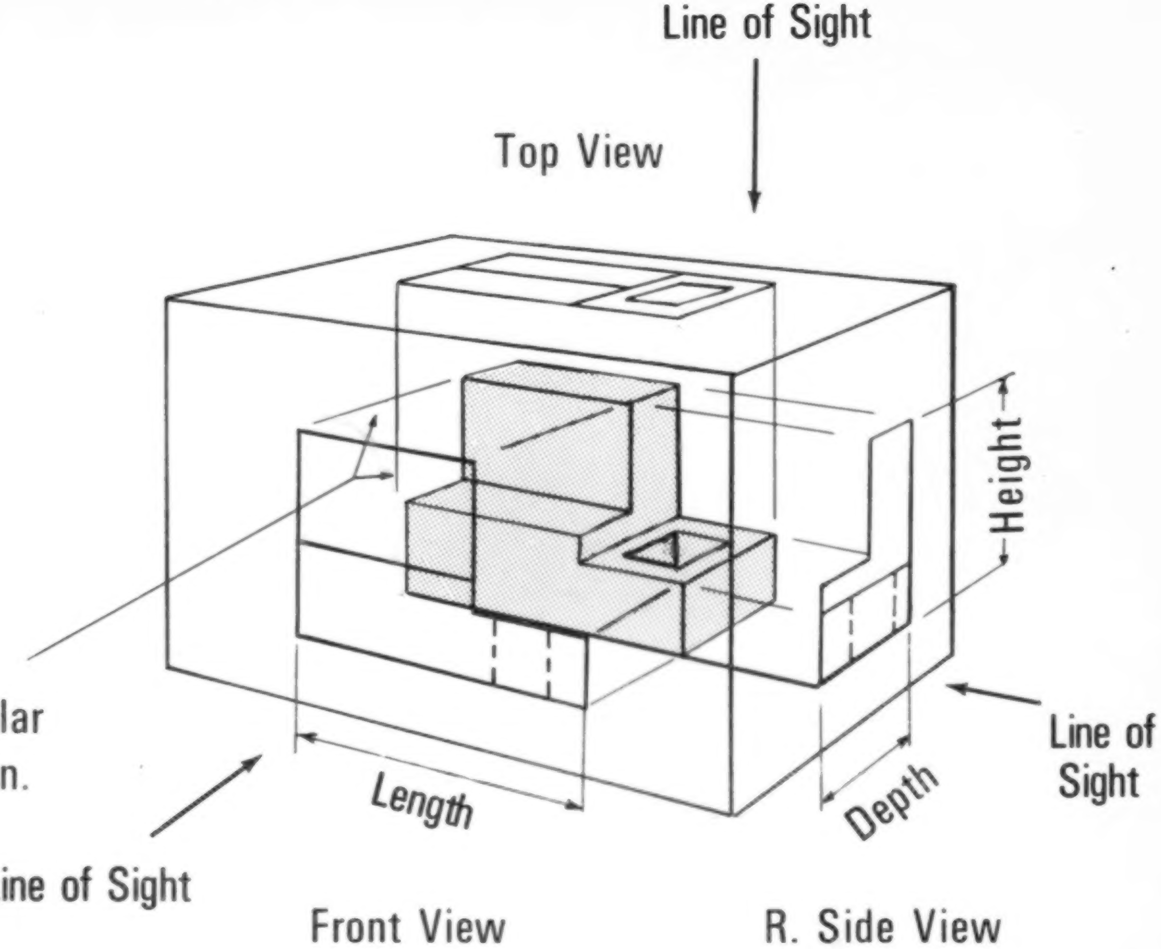
Orthographic Projection




Line of Sight
Top View
Height
Projectors perpendicular to planes of projection.
Length
Depth
Line of Sight
Line of Sight
Front View
R. Side View

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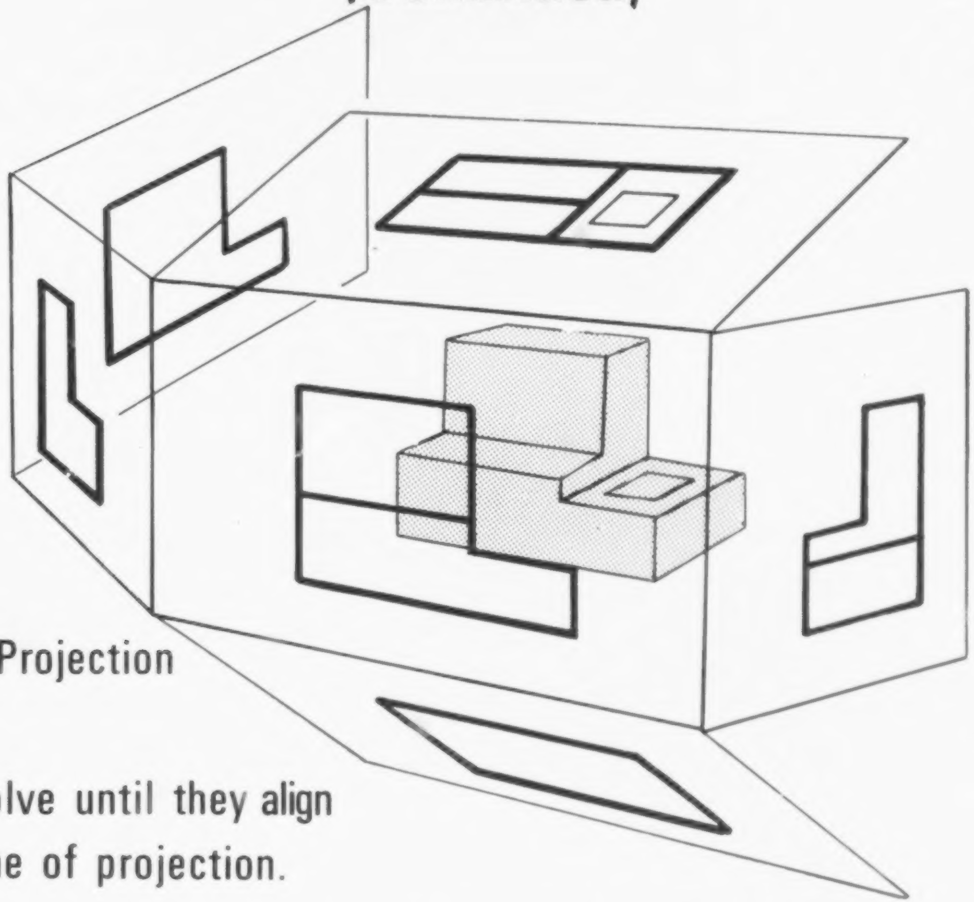
Orthographic Projection
(Continued)



Front Plane of Projection

All planes revolve until they align with front plane of projection.

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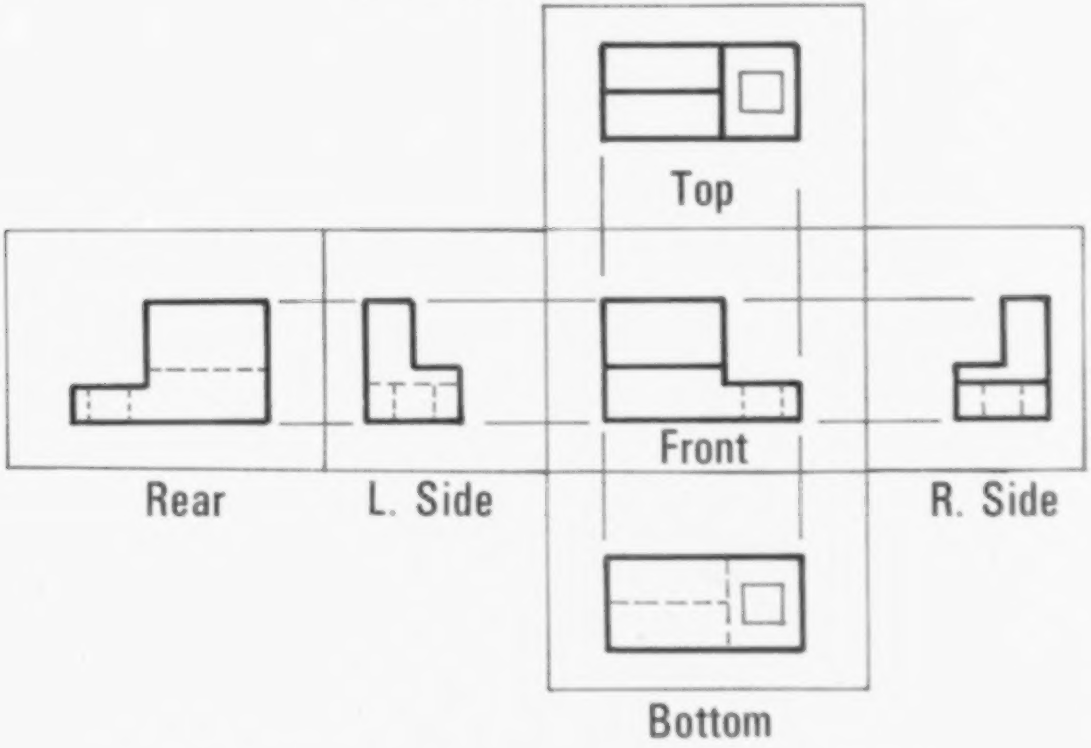
G102C-69

Orthographic Projection (Continued)


Top
Rear
L. Side
Front
R. Side
Bottom

The Six Planes are Laid on a Flat Plane as on a Drawing Surface.

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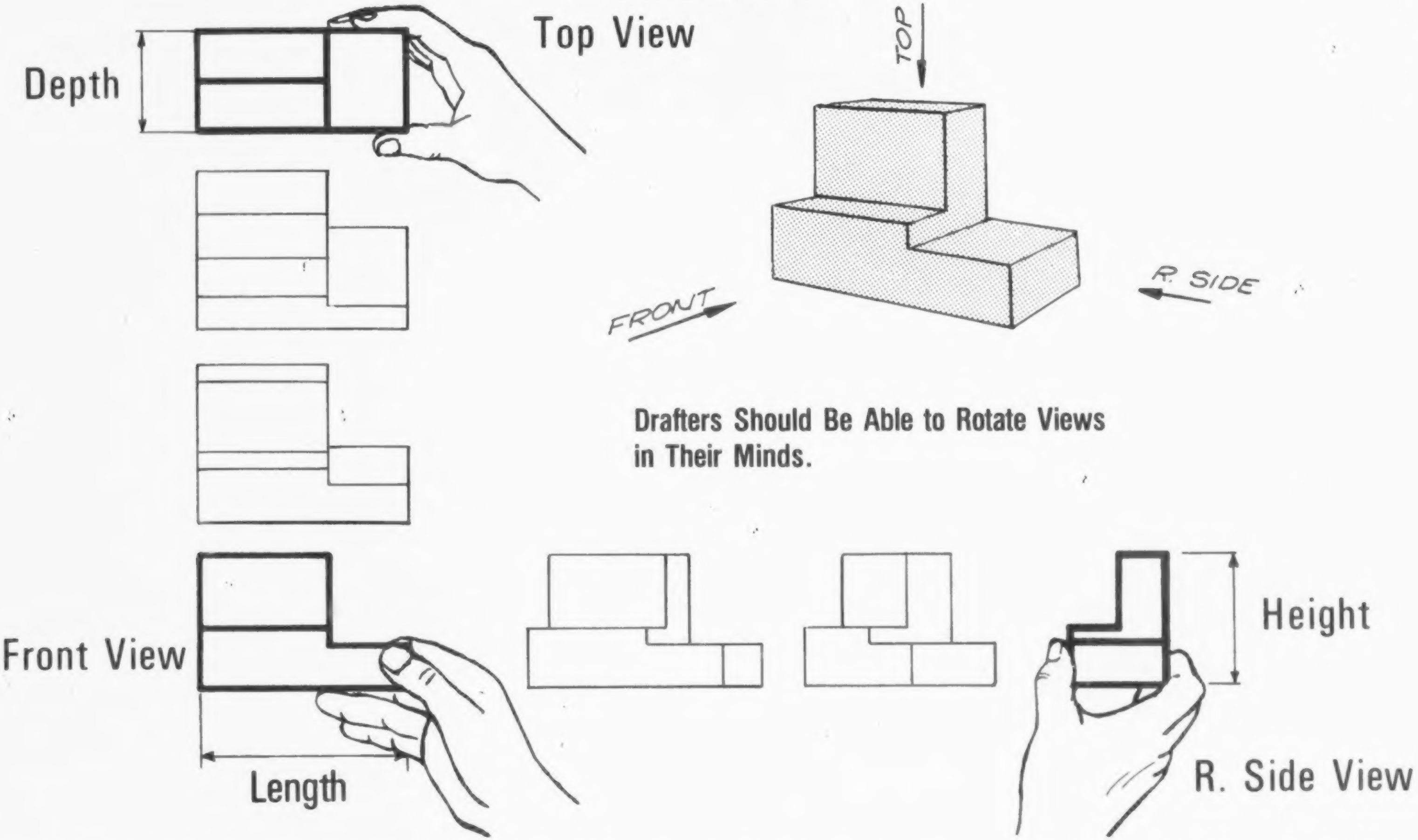
TM #13

Orthographic Projection (Continued)


Top View
Depth
TOP
FRONT
R. SIDE
Front View
Length
Height
R. Side View

Drafters Should Be Able to Rotate Views in Their Minds.

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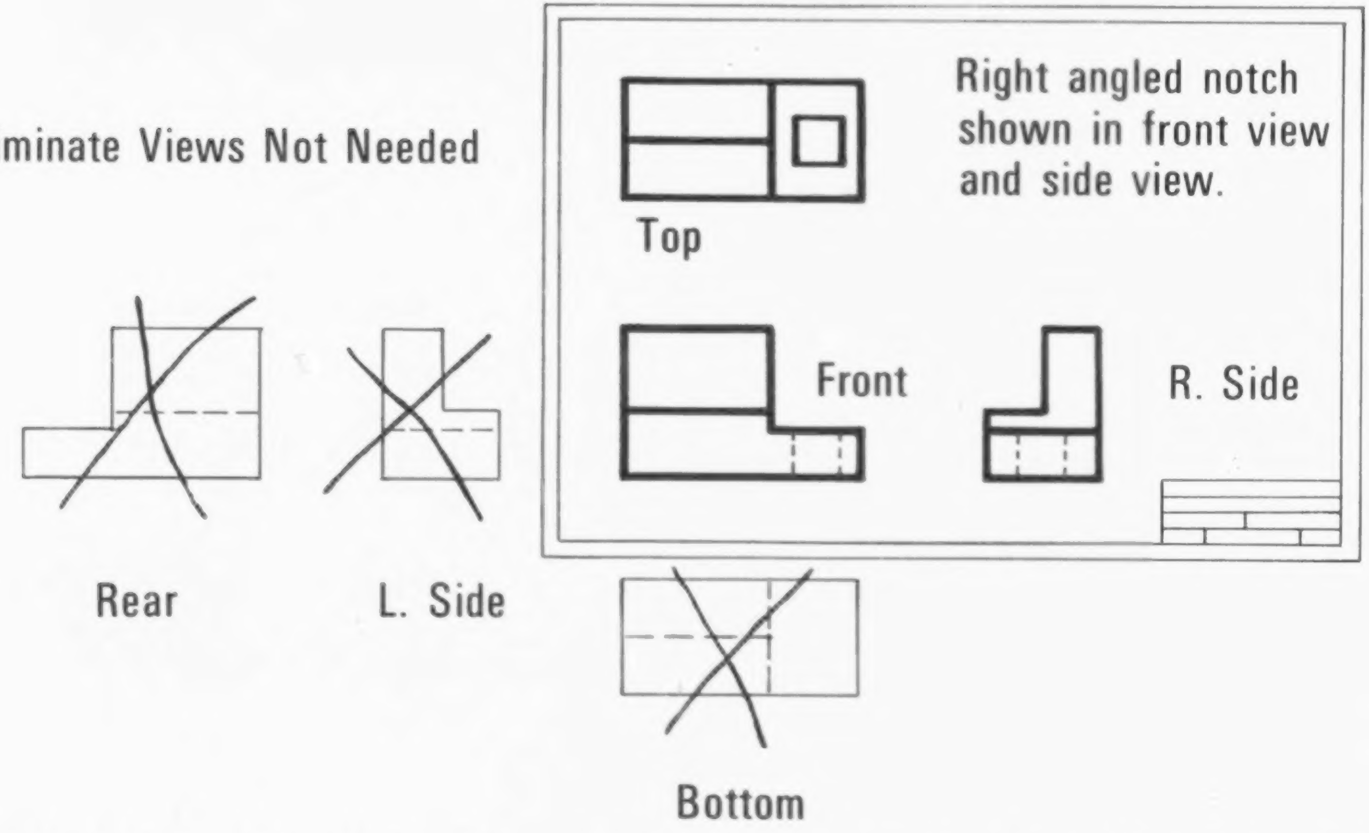
G102C-73

Principal Views in Orthographic Projection

Eliminate Views Not Needed


Top
Right angled notch shown in front view and side view.
Front
R. Side
Rear
L. Side
Bottom

TM #15

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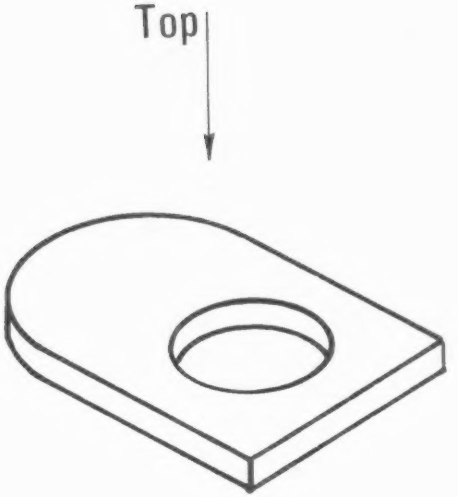
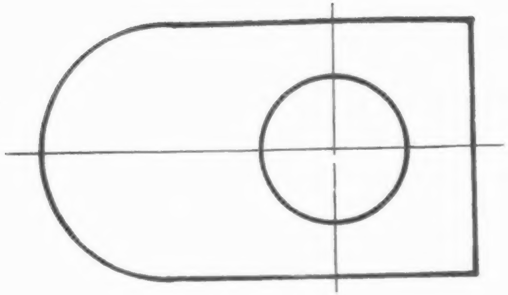
One-View Drawings



Objects with very little thickness require only one view.



Top View

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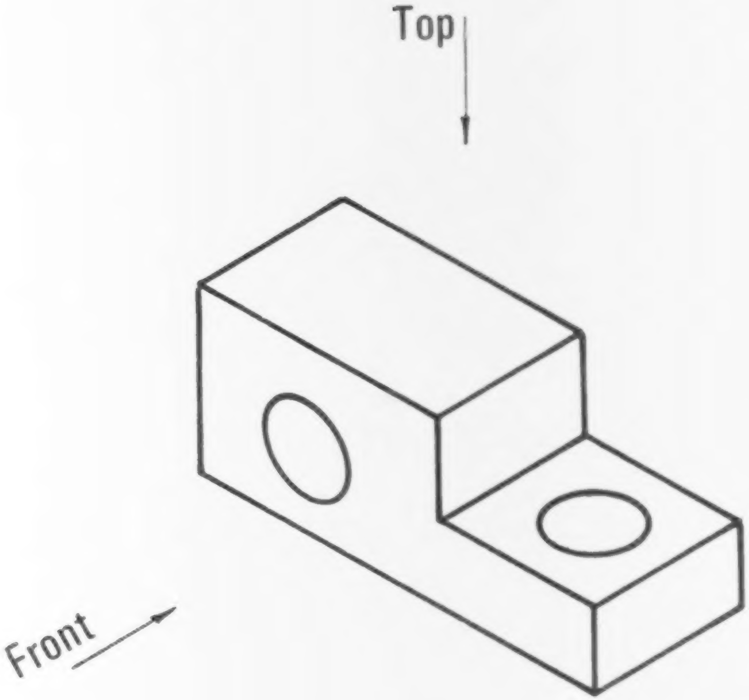
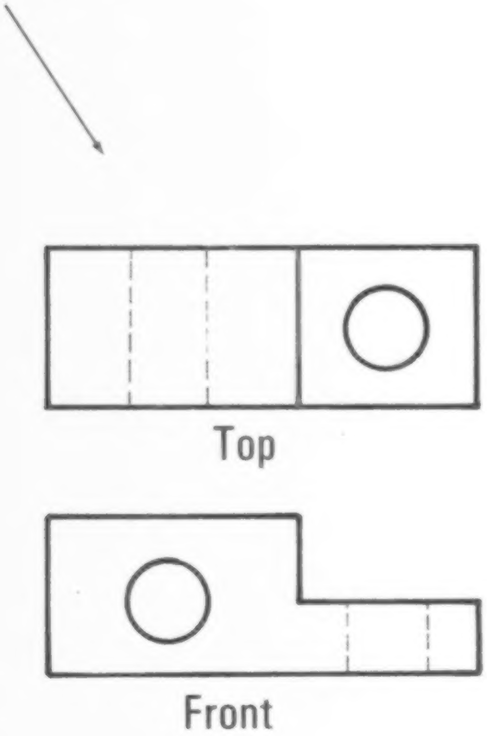
Two-View Drawings





Some objects require only two views.

G102C-77

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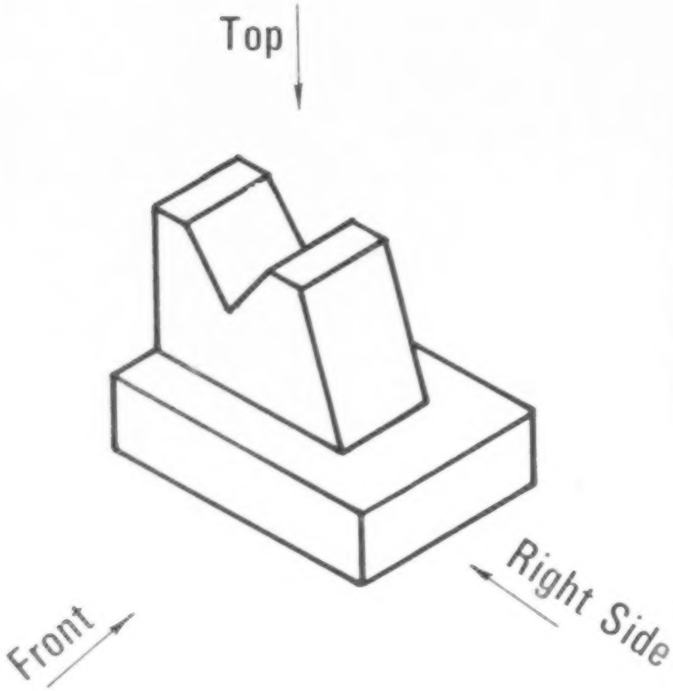
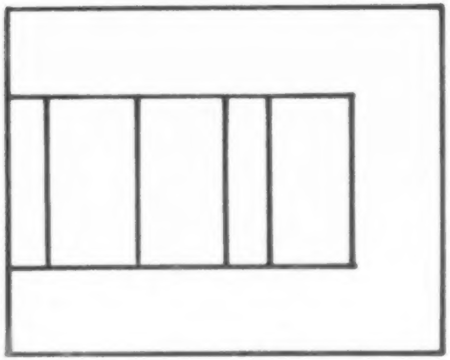
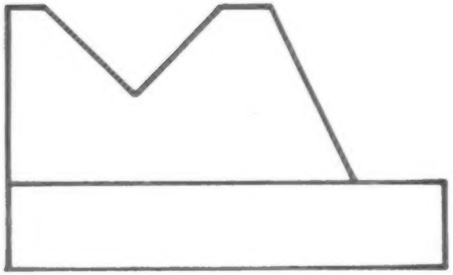
Three-View Drawings

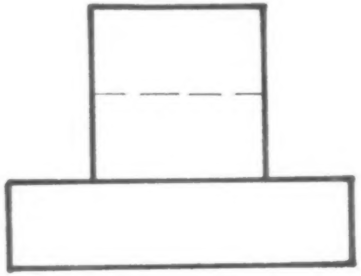




Top View



Front



Right Side

Some objects require three views to describe their shape.

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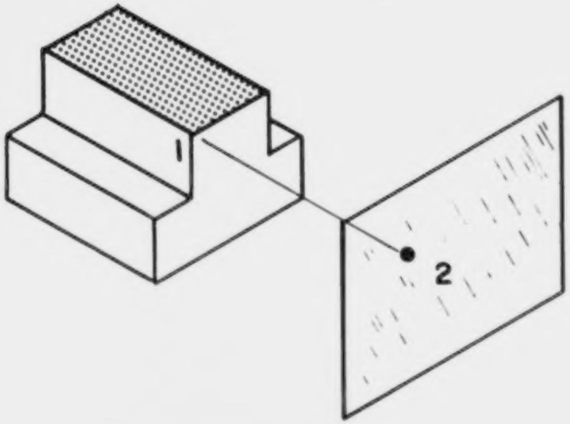
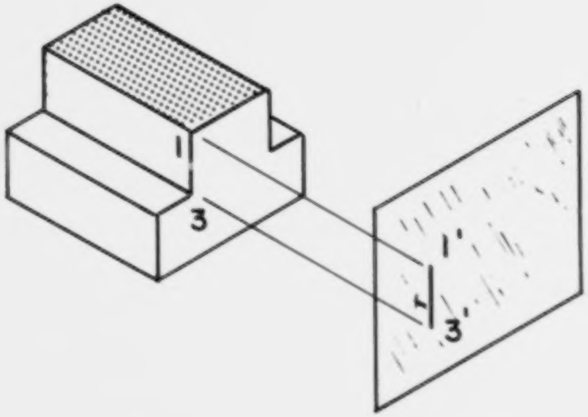
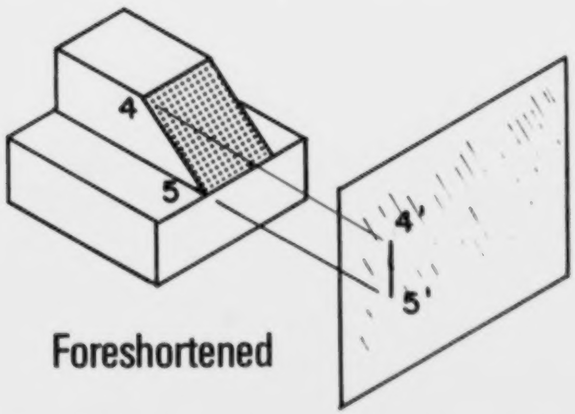
Projection of Lines in Orthographics



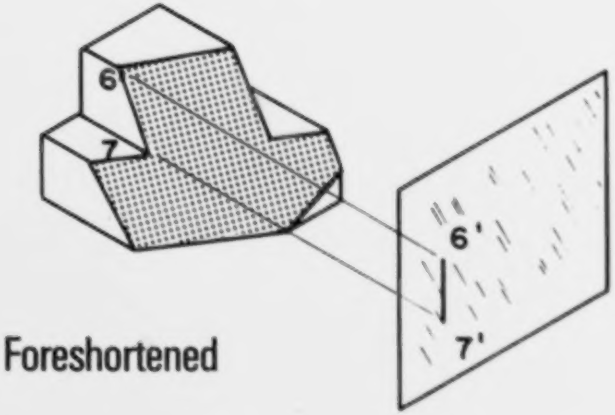
Point



True Length Line



Foreshortened



Foreshortened

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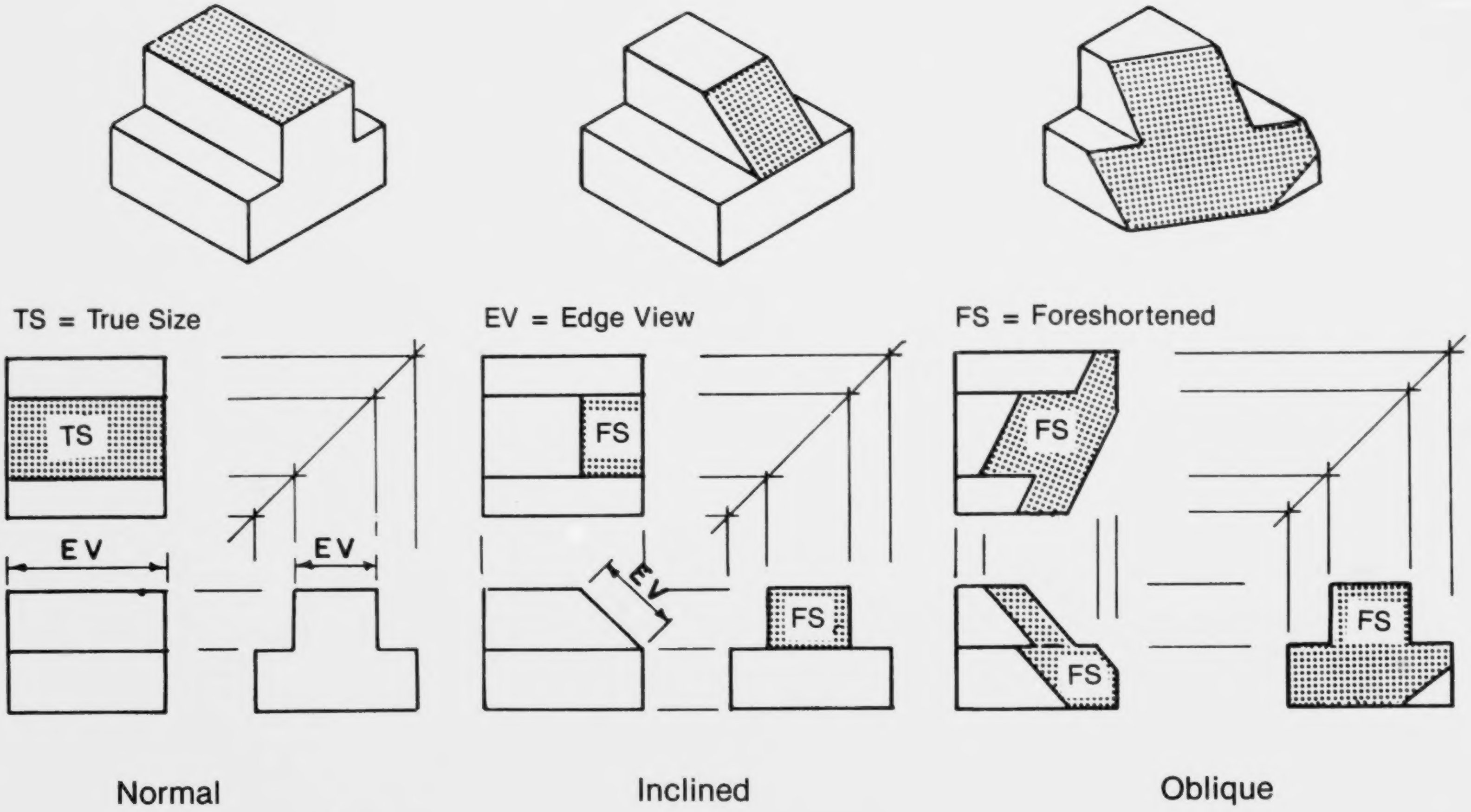
Planes in Orthographic Projection


TS = True Size
EV = Edge View
FS = Foreshortened
TS
EV
EV
FS
EV
FS
FS
FS
FS
Normal
Inclined
Oblique

G102C-83

TM #20

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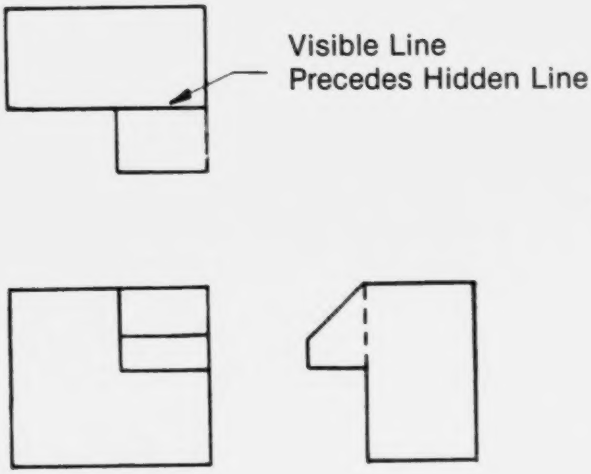
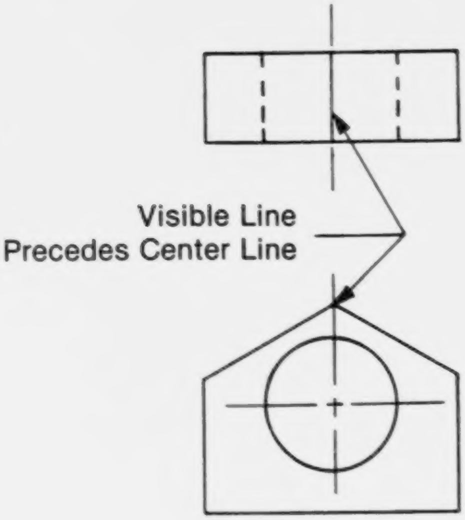
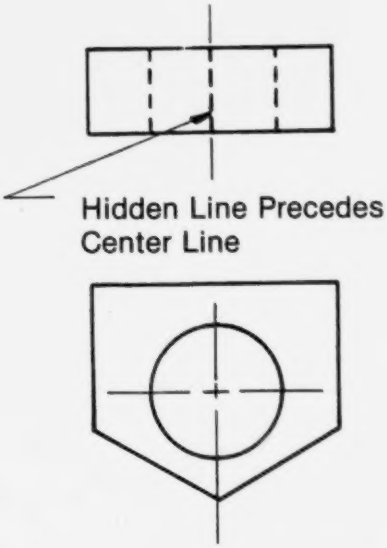
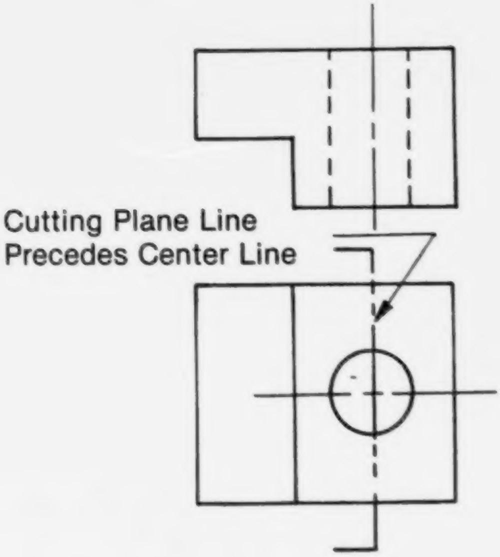
Line Precedence


Visible Line Precedes Hidden Line


Visible Line Precedes Center Line


Hidden Line Precedes Center Line


Cutting Plane Line Precedes Center Line

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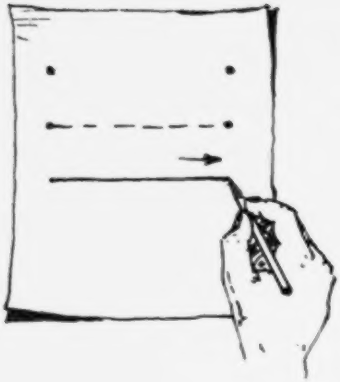
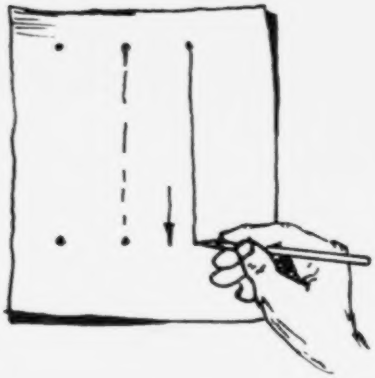
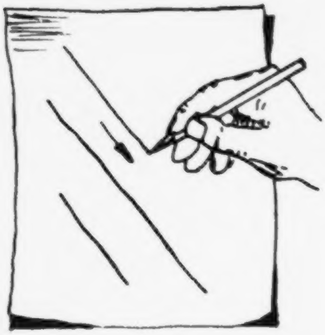
TM #21

Straight Line Sketches





Keep eye on end point



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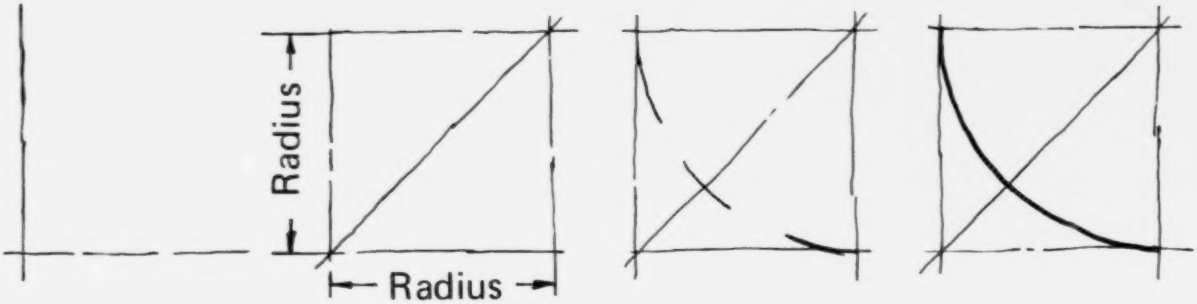
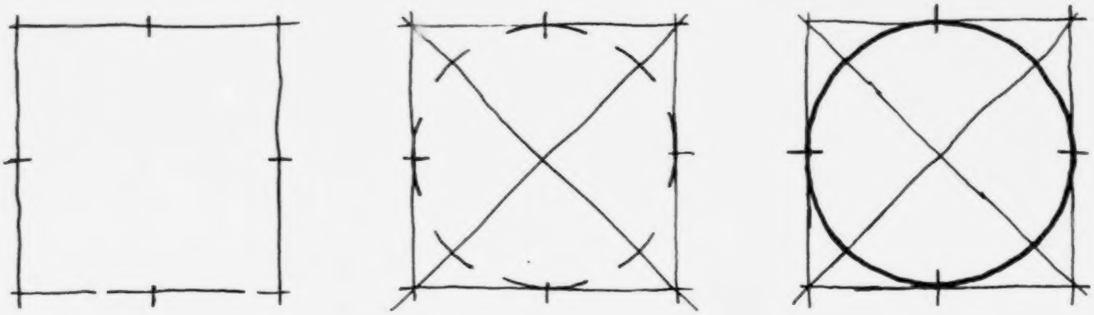
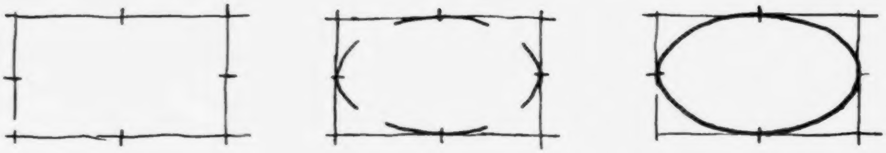
Sketching Arcs, Circles, and Ellipses

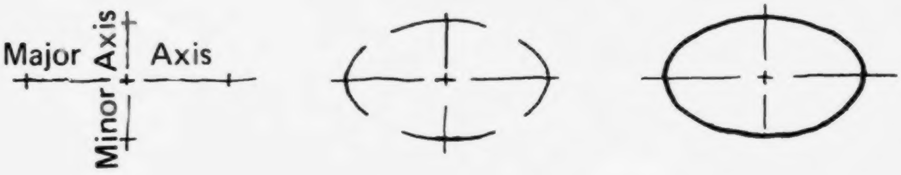

Radius
Radius



Method 1



Method 2


Major
Axis
Axis
Minor

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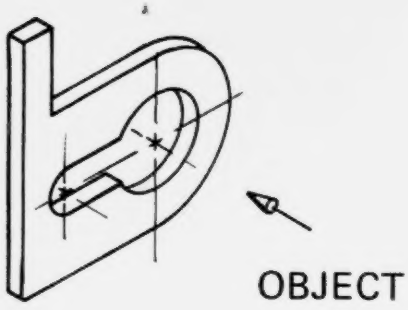
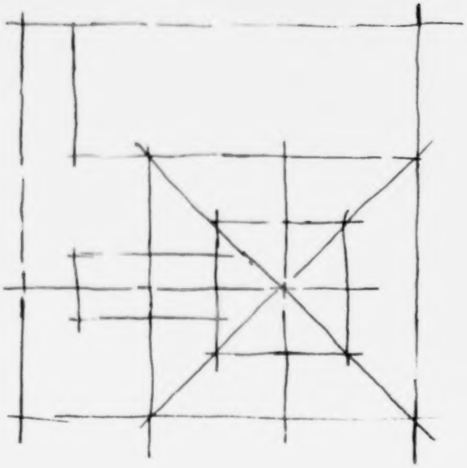
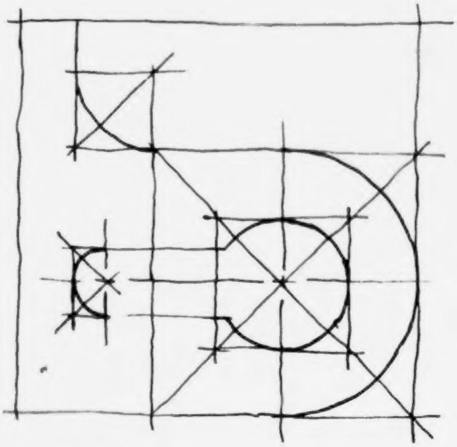
Steps in Blocking in a View



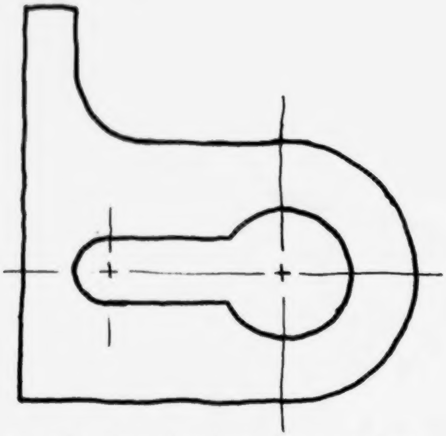
Block in Main Shapes



Sketch Arcs and Circles



Darken Final Lines



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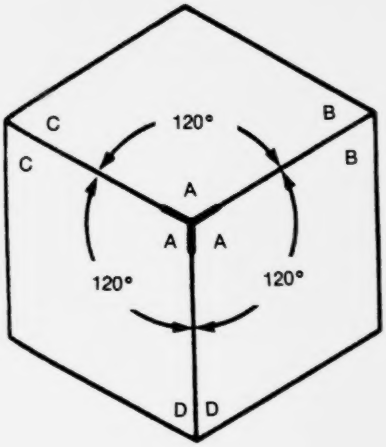
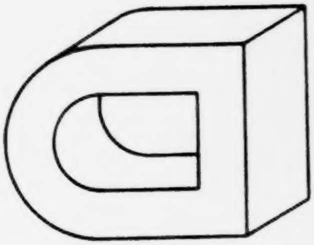
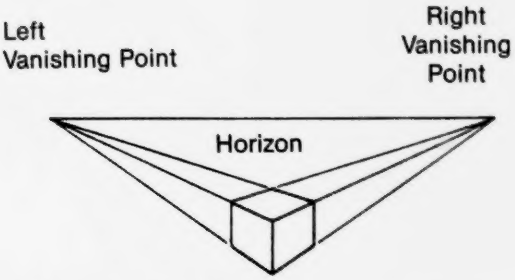
Types of Pictorial Drawings


C
C
120°
B
B
A
A
A
120°
120°
D
D

Isometric
(Most Commonly Used)



Oblique


Left
Vanishing Point
Right
Vanishing
Point
Horizon

Perspective

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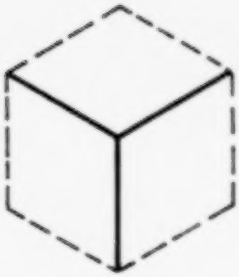
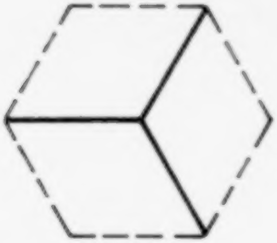
TM #25

Positions of Isometric Axis Lines

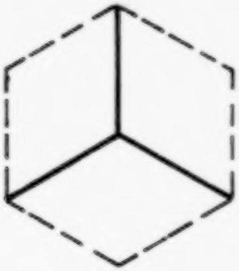


Top

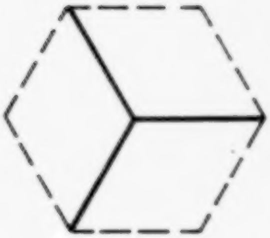
(Most Commonly Used)



Right Side



Bottom



Left Side

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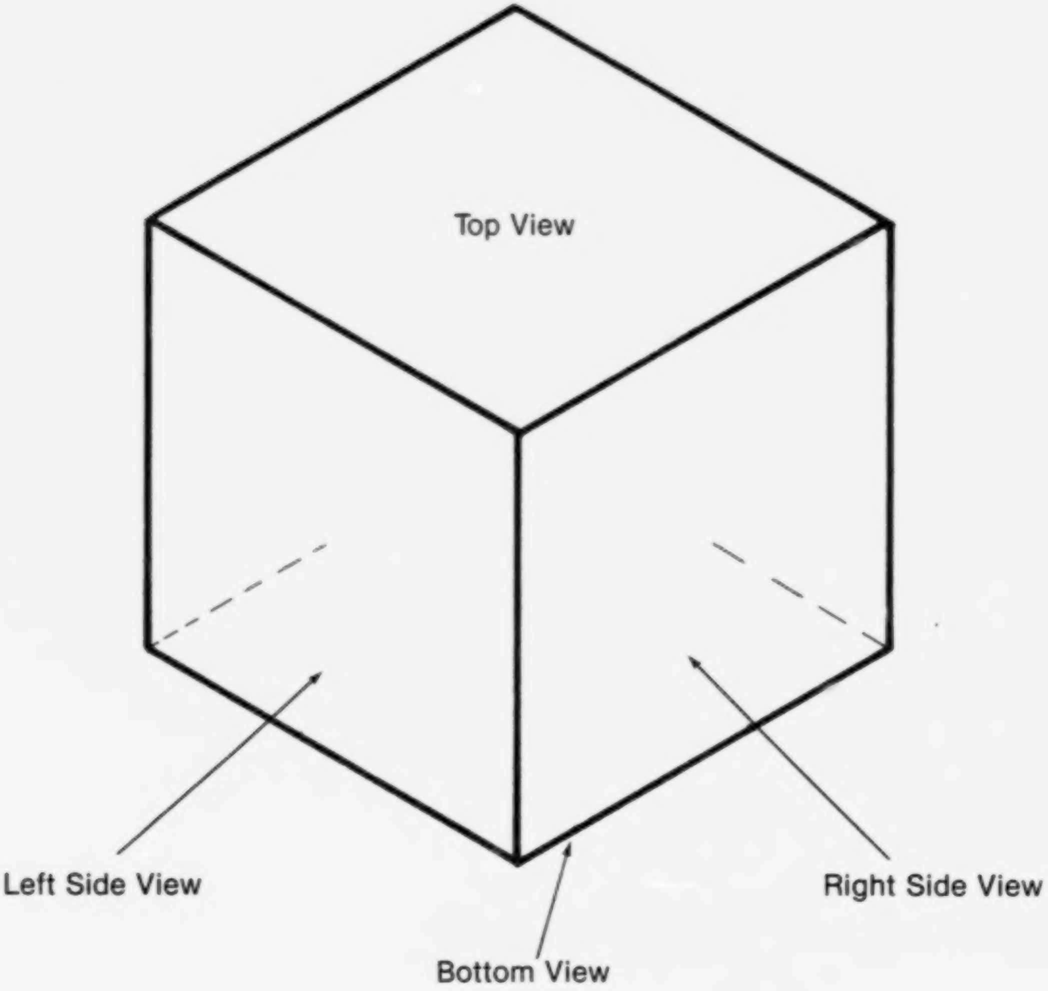
Surfaces on an Isometric


Top View
Left Side View
Right Side View
Bottom View

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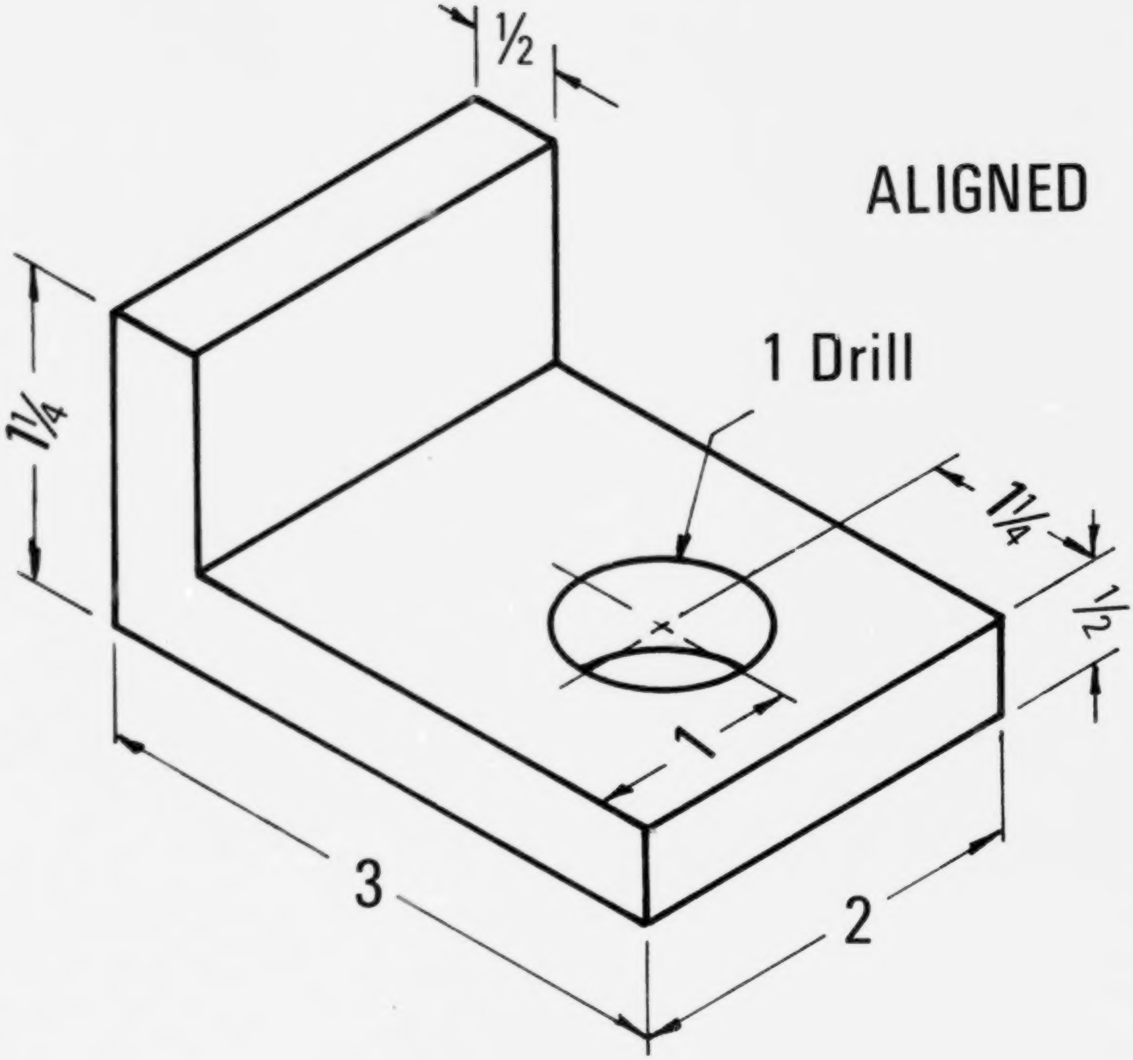
TM #27

Dimensioning Isometrics


½
ALIGNED
1 Drill
1¼
1¼
½
1
3
2

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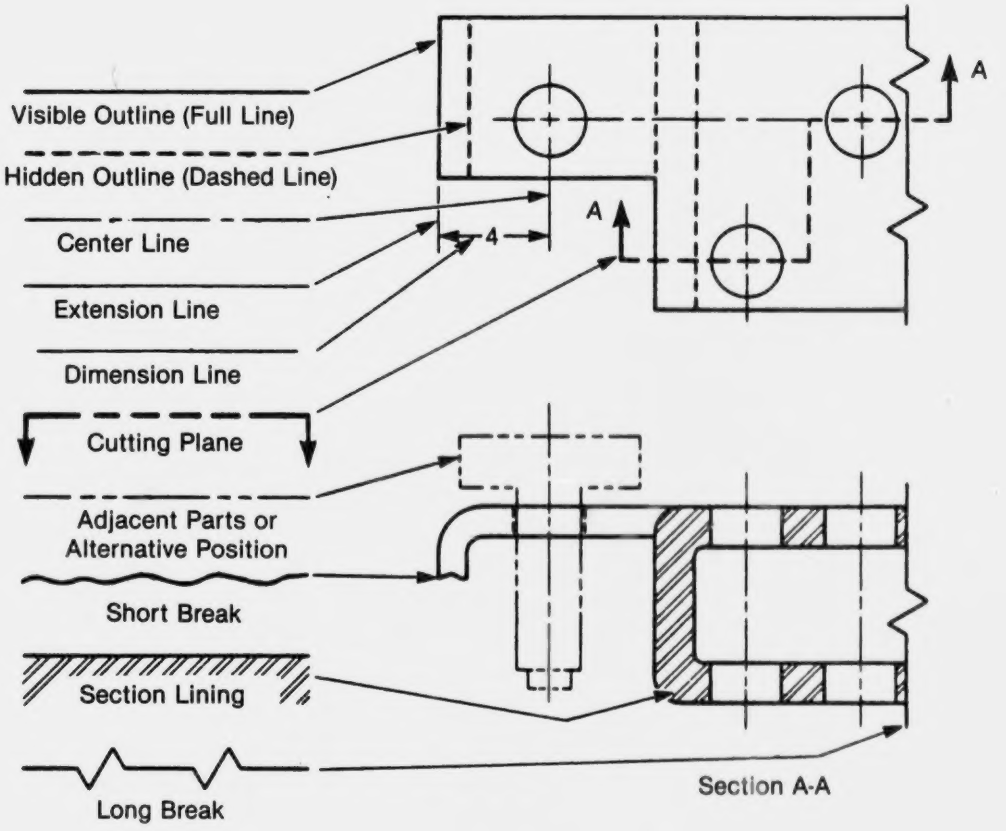
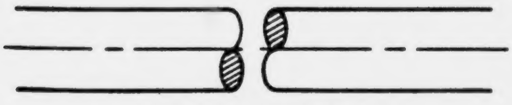
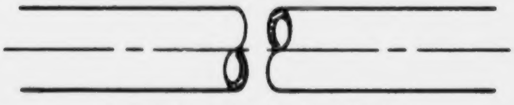
TM #28

Types of Lines


Visible Outline (Full Line)
Hidden Outline (Dashed Line)
Center Line
Extension Line
Dimension Line
Cutting Plane
Adjacent Parts or Alternative Position
Short Break
Section Lining
Long Break
A
A
4
Section A-A



Break Line for Solid Bar



Break Line for Hollow Tube

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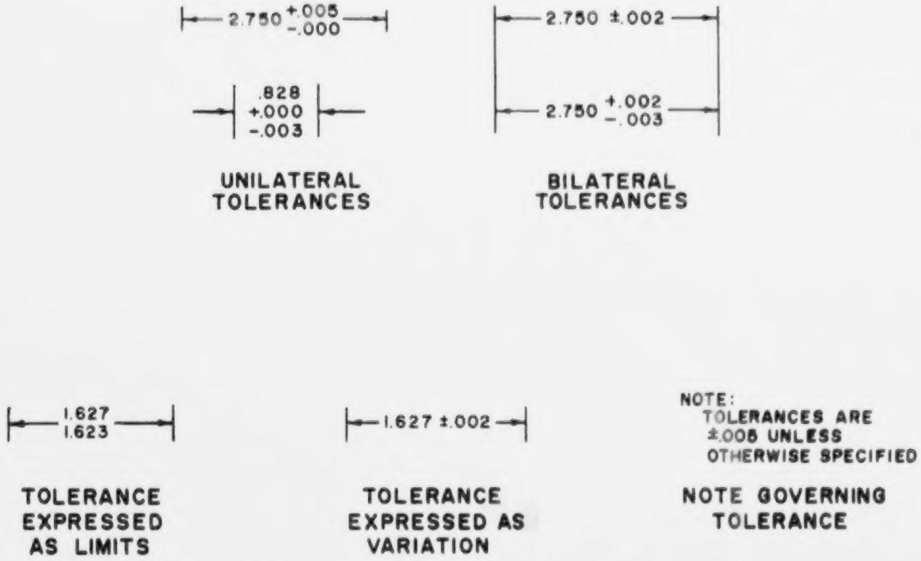
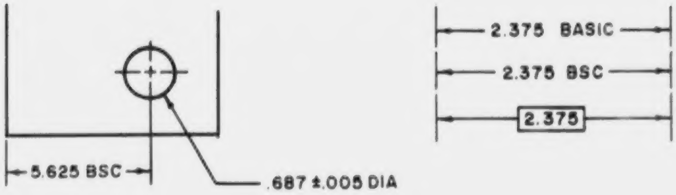
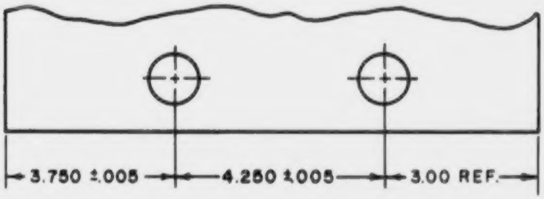
Types of Tolerances


2.750 +.005 −.000
.828 +.000 −.003
UNILATERAL TOLERANCES
2.750 ±.002
2.750 +.002 −.003
BILATERAL TOLERANCES
1.627
1.623
TOLERANCE EXPRESSED AS LIMITS
1.627 ±.002
TOLERANCE EXPRESSED AS VARIATION
NOTE:
TOLERANCES ARE ±.005 UNLESS OTHERWISE SPECIFIED
NOTE GOVERNING TOLERANCE

Indicating tolerances on drawings


5.625 BSC
.687 ±.005 DIA
2.375 BASIC
2.375 BSC
2.375

Indicating BASIC dimensions


3.750 ±.005
4.250 ±.005
3.00 REF.

Indicating reference dimensions

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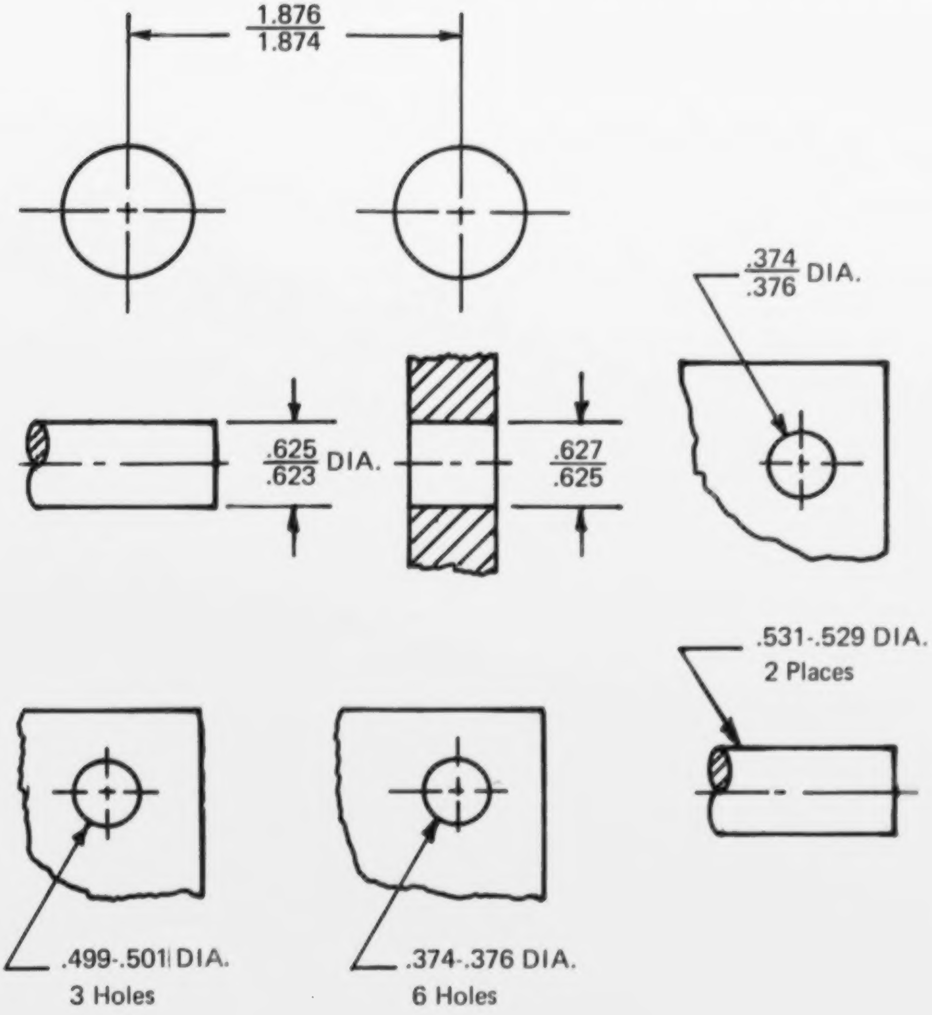
Application of Dimensioning



1.876
1.874
.374
.376 DIA.
.625
.623 DIA.
.627
.625
.531-.529 DIA.
2 Places
.499-.501 DIA.
3 Holes
.374-.376 DIA.
6 Holes

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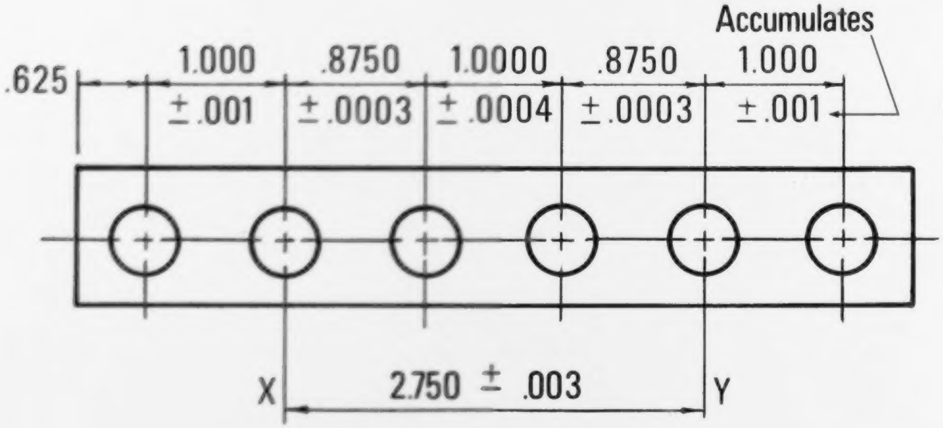
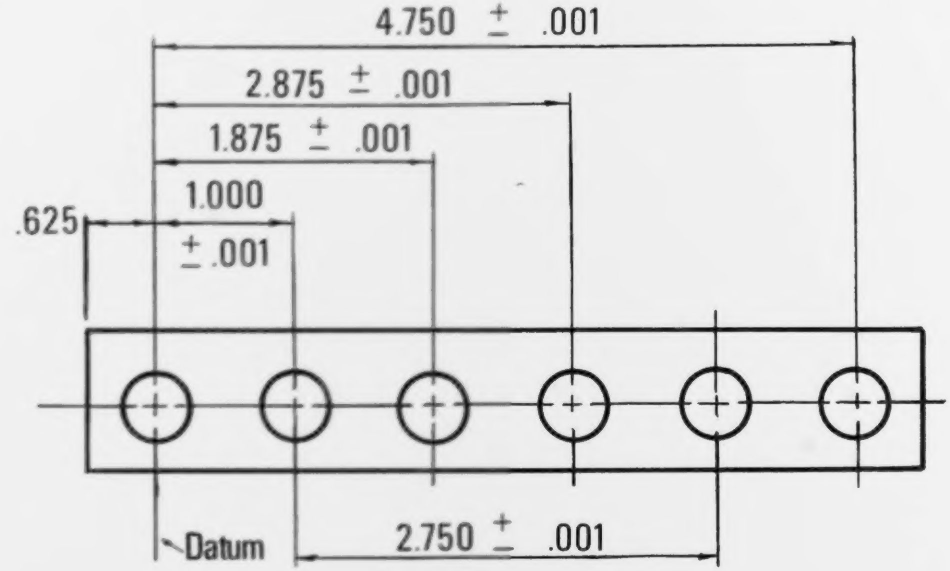
Types of Dimensioning Systems


Accumulates
.625
1.000
± .001
.8750
± .0003
1.0000
± .0004
.8750
± .0003
1.000
± .001
X
2.750 ± .003
Y

Point-to-Point or Chain Dimensioning


4.750 ± .001
2.875 ± .001
1.875 ± .001
.625
1.000
± .001
Datum
2.750 ± .001

Datum Dimensioning

TM #32

GENERAL
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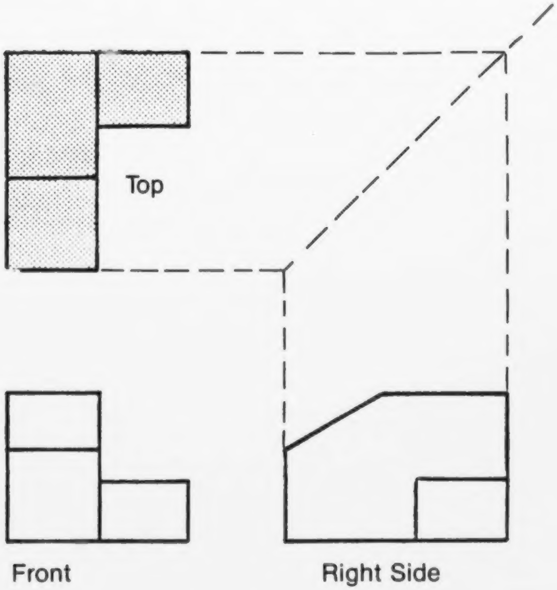
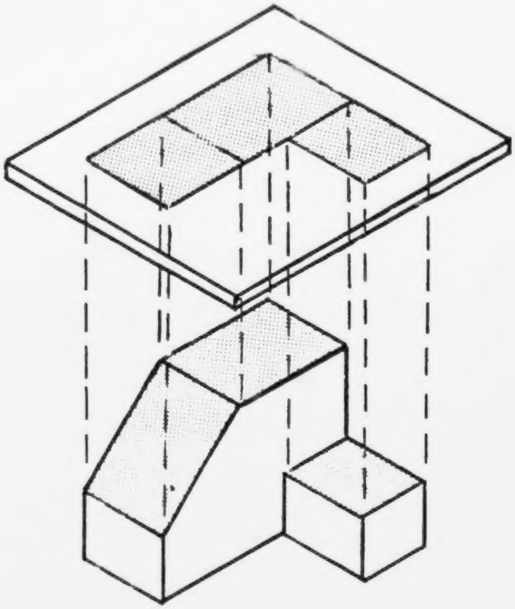
G102-C

WORKBOOK SUPPLEMENT #1--Construct a Top View

One of the three most commonly used views in an orthographic projection is the top view. The top view is first viewed on an imaginary plane, and then drawn in its correct position using the mitre method of transferring dimensions. By practicing the construction of simple top views, you will gain a better understanding of how to interpret them in aircraft drawings. The following is an example of a top view.

EXAMPLE:

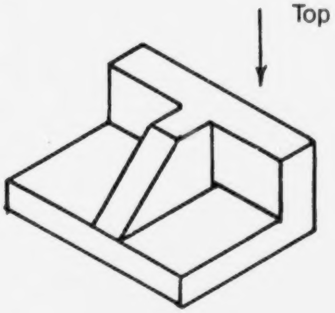


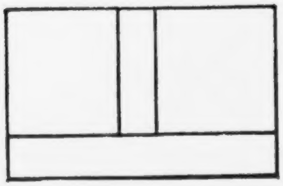


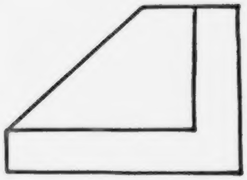
WORKBOOK SUPPLEMENT #1

Directions: Sketch top views of the following objects. Do not show hidden lines.

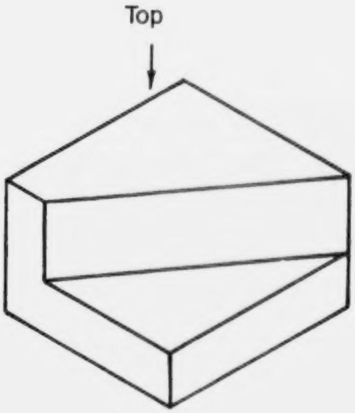
A.

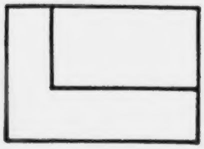


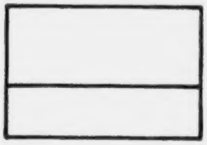




B.

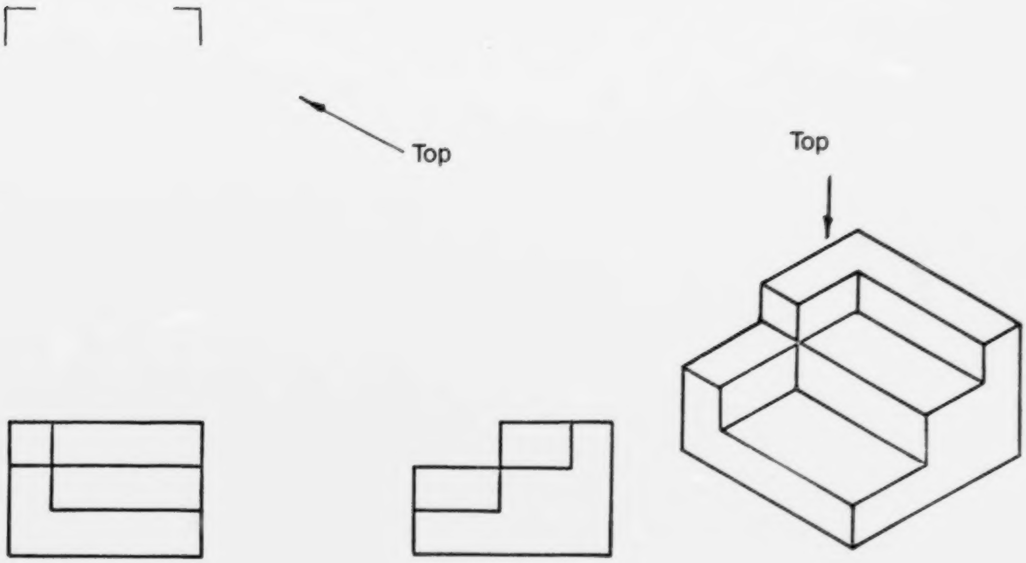




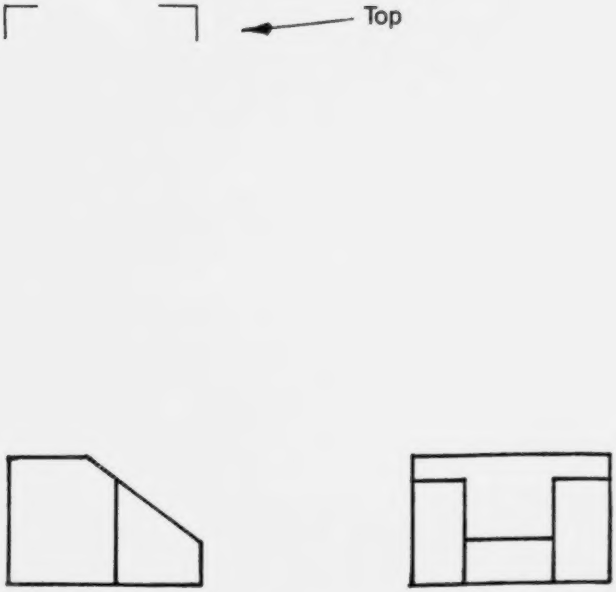


WORKBOOK SUPPLEMENT #1

C.



D.



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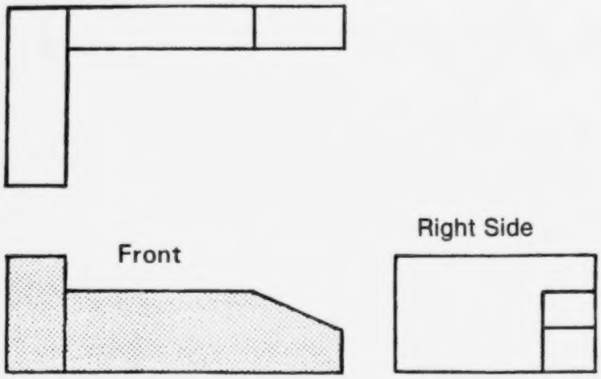
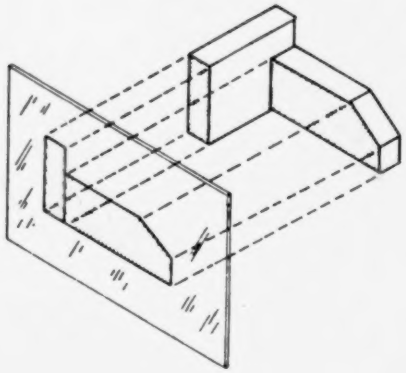
WORKBOOK SUPPLEMENT #2--Construct a Front View

Like the top view, the front view is an orthographic projection. The front view is first viewed on an imaginary plane, and then drawn in its correct position. The following is an example of this process. By practicing the construction of a front view, you will better understand its use in aircraft drawings.

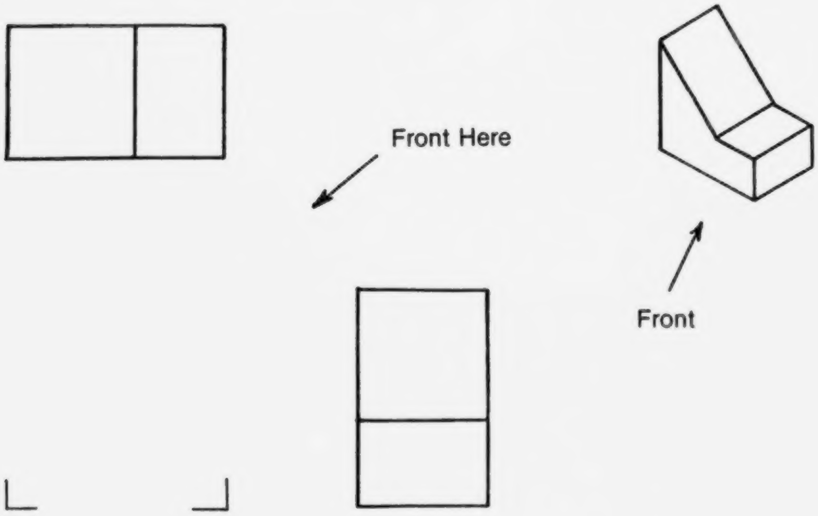
EXAMPLE:





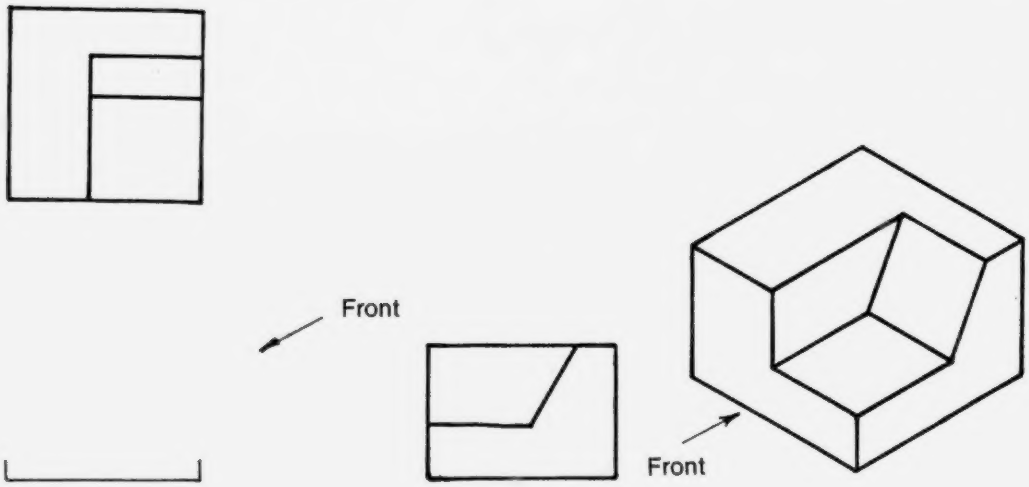
Directions: Construct the front views of the following objects. Do not show hidden lines. Drawings do not have to be drawn to scale.

A.

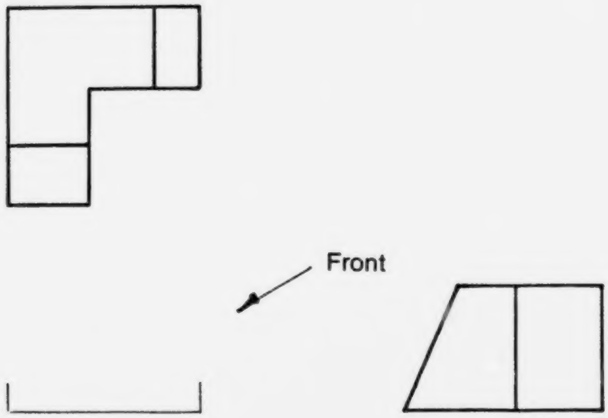


WORKBOOK SUPPLEMENT #2

B.



C.



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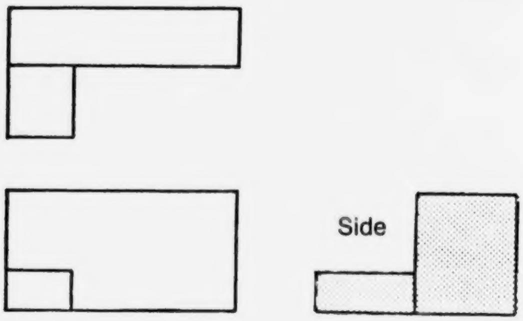
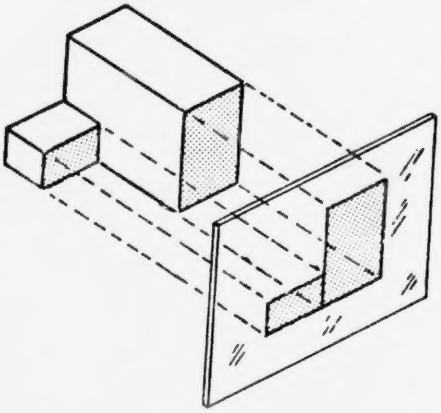
WORKBOOK SUPPLEMENT #3--Construct a Right-Side View

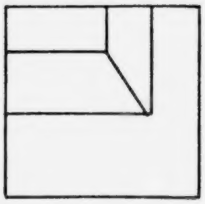
The third of the three most common views in an orthographic projection is the right-side view. The right-side view is first viewed on an imaginary plane and then drawn in its correct position. Using the following example as a guide, construct the right-side views of the following objects. Do not show hidden lines. Drawings do not have to be drawn to scale.

EXAMPLE:

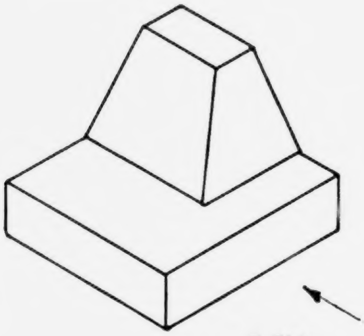


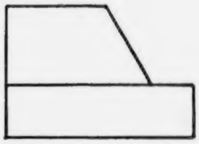


A.

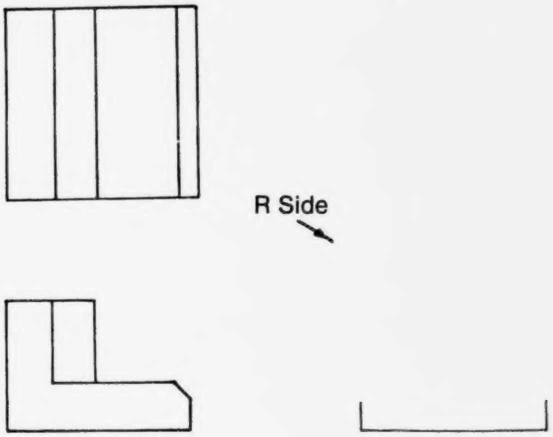

Top

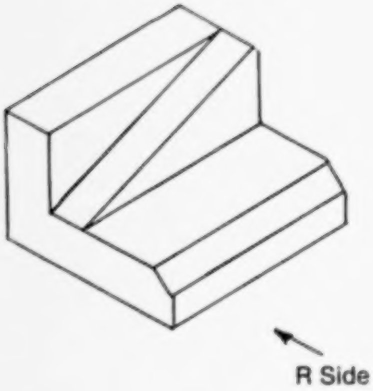
R Side


R Side

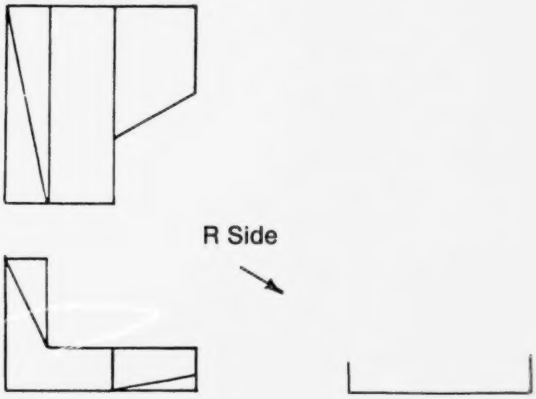

Front

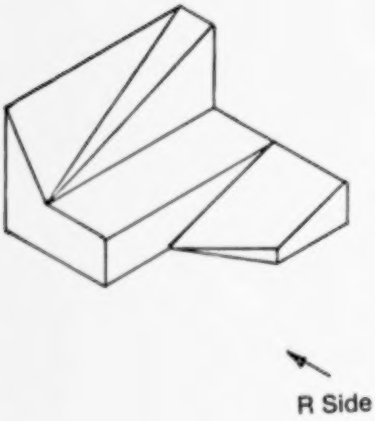
B.





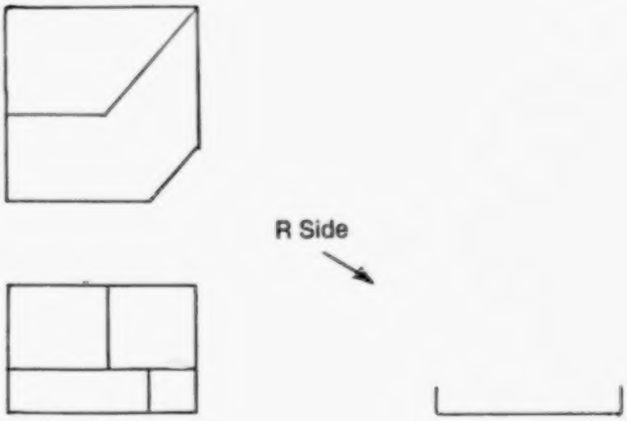
C.





WORKBOOK SUPPLEMENT #3

D.



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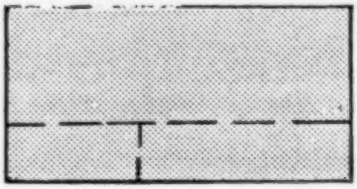
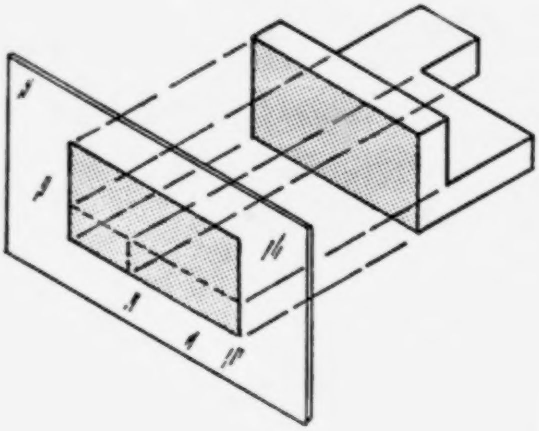
WORKBOOK SUPPLEMENT #4--Construct Missing Hidden Lines

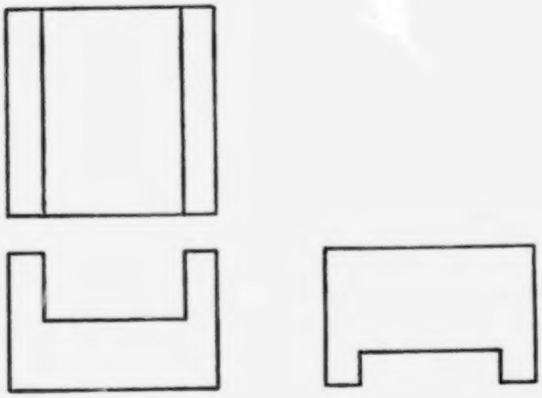
Hidden lines provide additional information about features of a part which are not visible in a given view. Practicing the construction of these lines will aid you in interpreting them in aircraft drawings.

EXAMPLE:

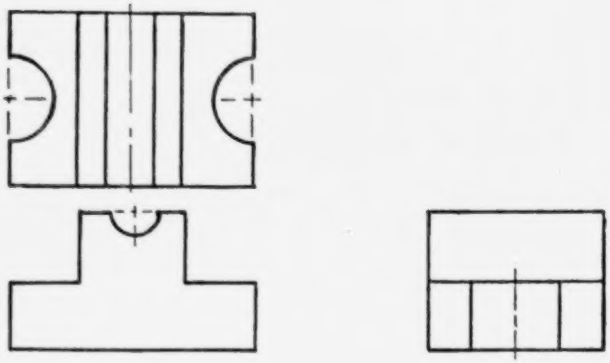




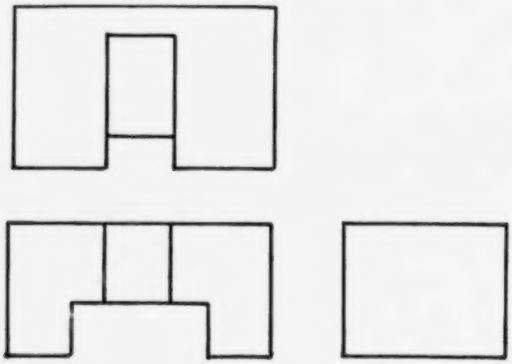
A. Directions: Using the example above as a guide, construct the missing hidden lines in the following views. Drawings do not have to be drawn to scale.



B.

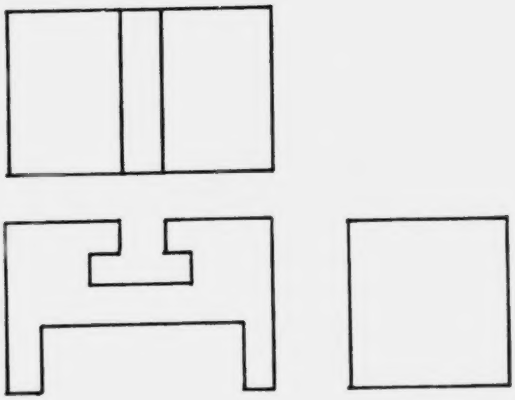


C.



WORKBOOK SUPPLEMENT #4

D.



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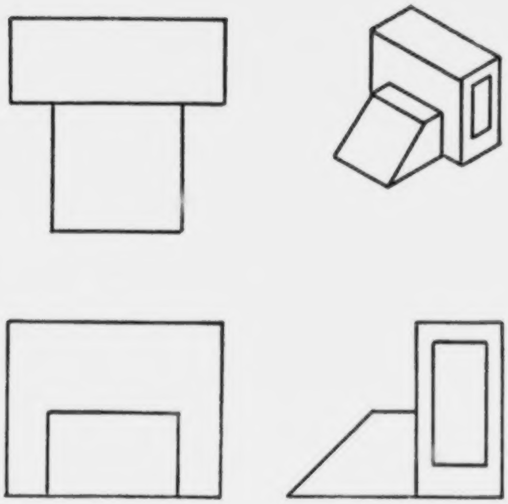
WORKBOOK SUPPLEMENT #5--Construct Missing Visible and Hidden Lines

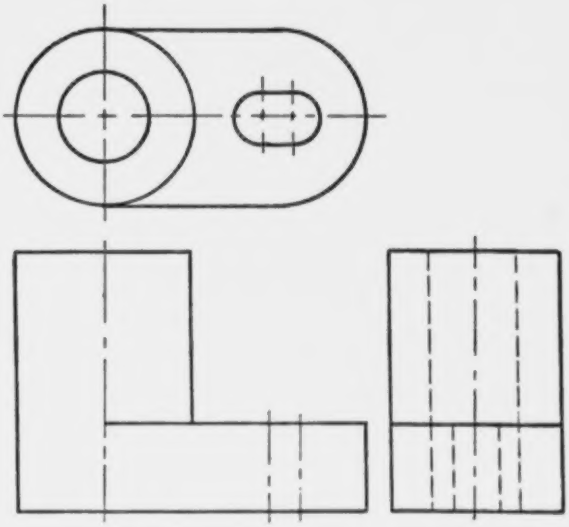
It is important to distinguish between visible and hidden lines, and to interpret a drawing when the two happen to coincide. The following exercises will allow you to interpret these lines as they occur in aircraft drawings.

Study the following views and construct the missing visible and hidden lines. Drawings do not have to be drawn to scale.

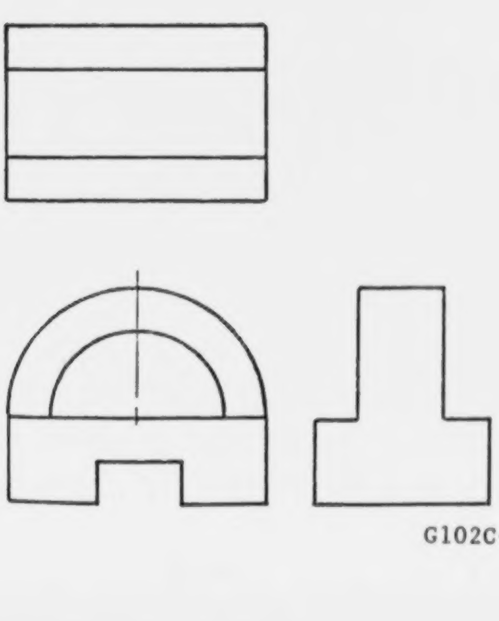
A.



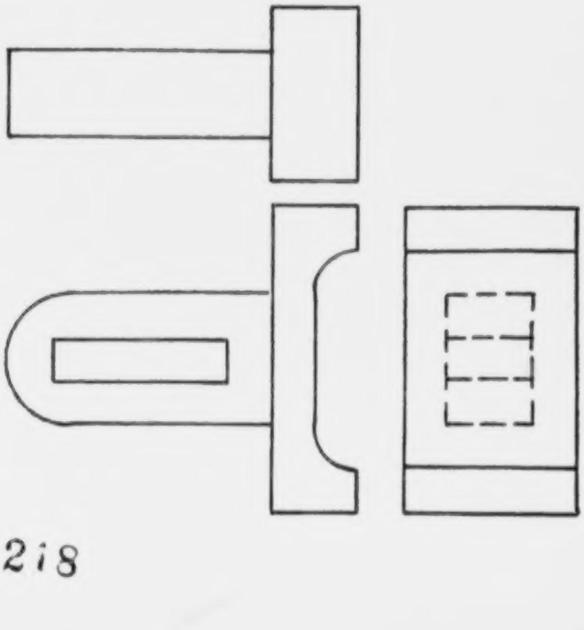
B.



C.

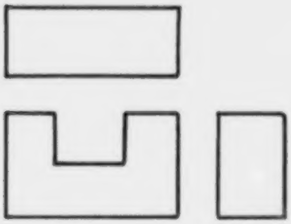


D.

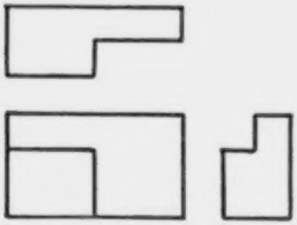


WORKBOOK SUPPLEMENT #5

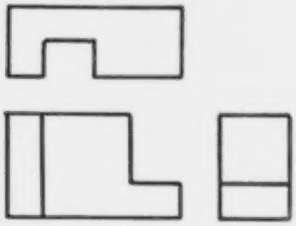
E.



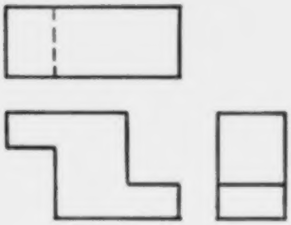
F.



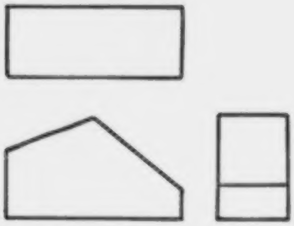
G.



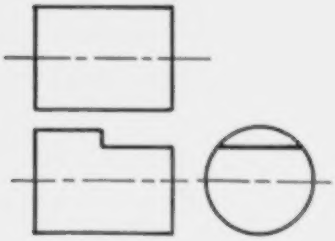
H.



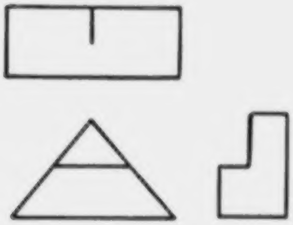
I.



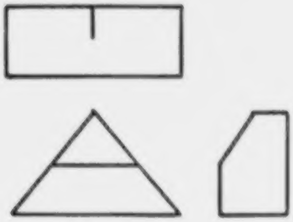
J.



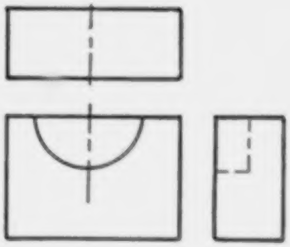
K.



L.

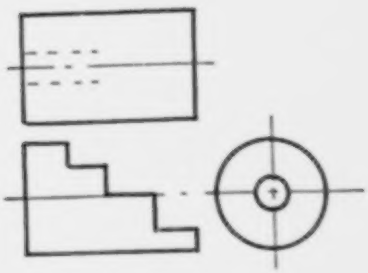


M.

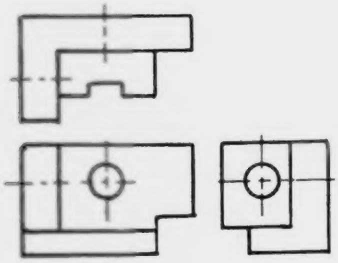


WORKBOOK SUPPLEMENT #5

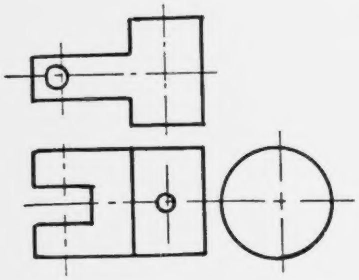
N.



O.



P.



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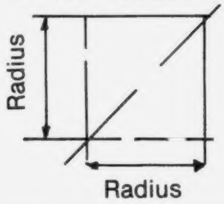
WORKBOOK SUPPLEMENT #6--Sketch Arcs

Arcs can be sketched by using the procedures in the following example.

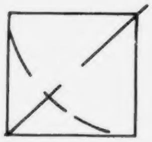
EXAMPLE:

1. Sketch a box corner.

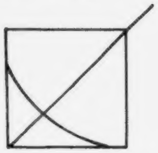
2. Mark off radius distance from corner point.



3. Swing a rough arc from center point.

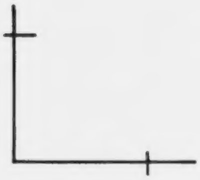


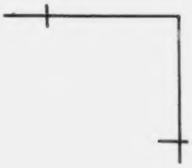
4. Darken arc.

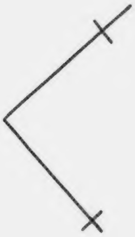


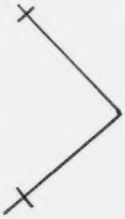
WORKBOOK SUPPLEMENT #6

Directions: Sketch arcs in the following corners.









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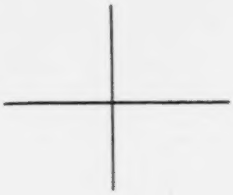
WORKBOOK SUPPLEMENT #7--Sketch Circles

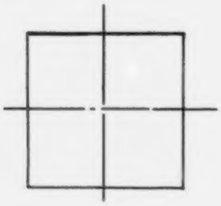
Circles can be sketched by using the procedures in the following example.

EXAMPLE:

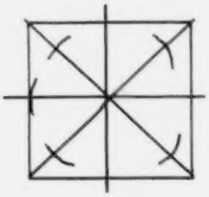
1. Sketch in center line.



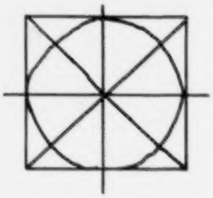
2. Box in circle at diameter required.



3. Put in diagonal lines and mark radius points from center.



4. Rotate wrist in a circular motion and connect circle points.



WORKBOOK SUPPLEMENT #7

Directions: Sketch three circles below using 1/2-inch approximate radius.

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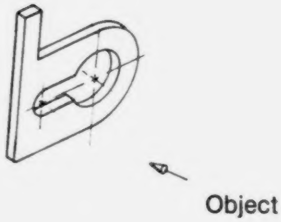
WORKBOOK SUPPLEMENT #8--Sketch an Object Using Arcs and Circles

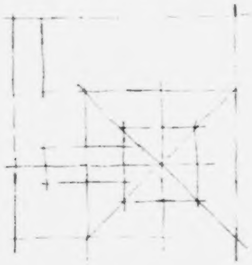
An object using arcs and circles can be sketched by using the procedure in the following example.

EXAMPLE:

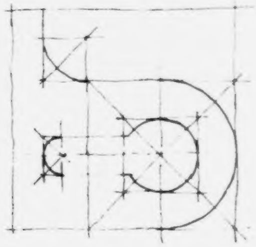
1. Decide which view of object is to be drawn.



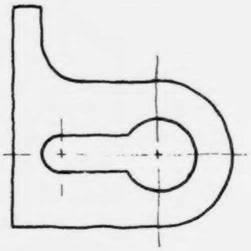
2. Box in overall shape of object.



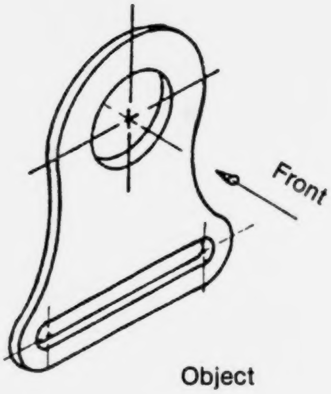
3. Sketch in arcs and circles.



4. Erase construction lines and darken object.



Directions: Sketch the front view of the following object. Drawing does not have to be drawn to scale.



Object

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WORKBOOK SUPPLEMENT #9--Make a Two-View Sketch

The ability to make a sketch of an object or repair is essential to every aviation technician. Use the procedure outlined in the following example to construct a two-view sketch of an object.

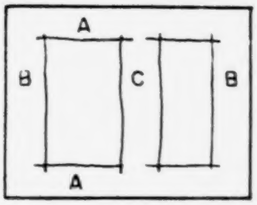
EXAMPLE:

1. Sketch the horizontal lines to locate the height of the object.

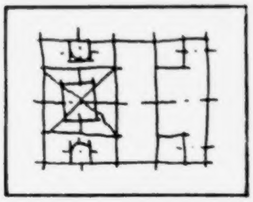
   (NOTE: The distance at the top and bottom of the paper should be the same.)

2. Sketch the vertical lines to locate the width and depth of the object.

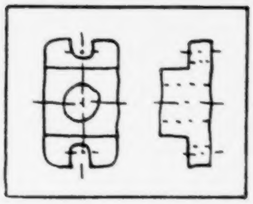
   (NOTE: The distance at the left side and right side of the paper should be the same. The distance between the views can be the same as that on the left side and right side or slightly less than that space.)



3. Block in details using diagonals to locate centers, and lightly sketch the circles and arcs.

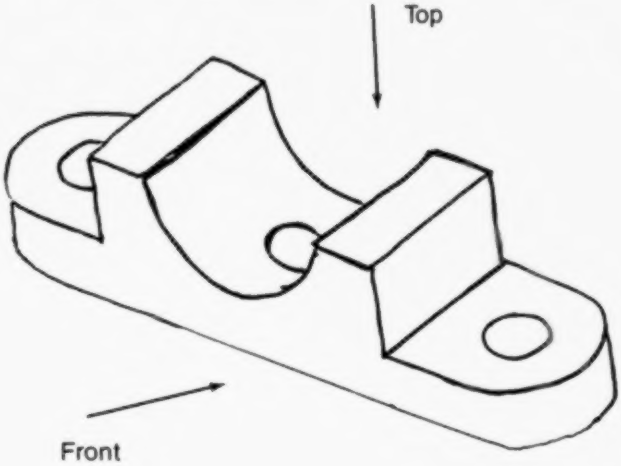


4. Use an artgum eraser to dim construction lines and darken visible lines.



WORKBOOK SUPPLEMENT #9

Directions: Make a two-view sketch of the following object. Drawing does not have to be drawn to scale.



← Top

← Front

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WORKBOOK SUPPLEMENT #10--Make a Three-View Sketch

The skills you practiced when constructing a two-view sketch can also be used for a three-view sketch. Normally, the subject of a three-view sketch is a little more complex, and the third view is required to completely define the part. This workbook supplement will bring together everything you have learned so far to create and interpret aircraft drawings.

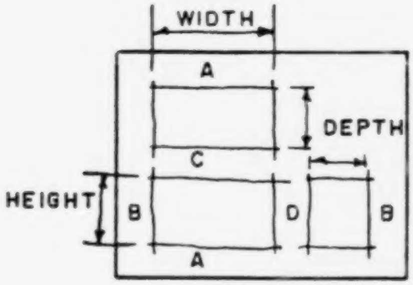
Use the procedures outlined in the following example to construct a three-view sketch.

EXAMPLE:

1. Sketch the horizontal lines to locate the height of the object.

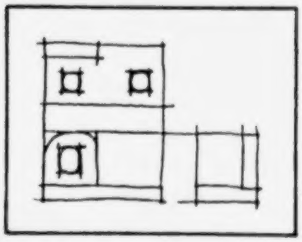
   (NOTE: The distance at the top and bottom of the paper should be the same. The distance between the top and front views can be the same as that of the top and bottom or slightly less than that space.)

2. Sketch the vertical lines to locate the width and depth of the object.



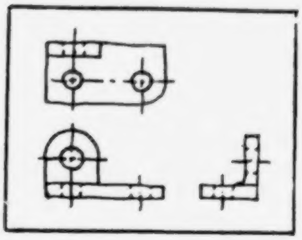
   (NOTE: The distance at the left side and right side of the paper should be the same. The distance between the views can be the same as that on the left side and right side or slightly less than that space. In the top and side views, the depth must be equal; this can be done by marking a piece of paper with depth.)

3. Block in details, using diagonals to locate centers, if necessary; and lightly sketch the circles and arcs.

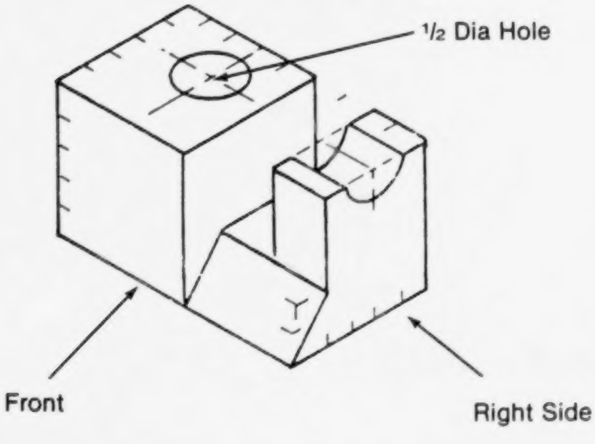


4. Add line features to the views of the object.

5. Use an artgum eraser to dim construction lines. Darken visible lines.



Directions: Construct three full-size views of the object shown below. Each mark is equal to 1/4 inch. Drawing must be drawn to scale. Use another sheet of paper.



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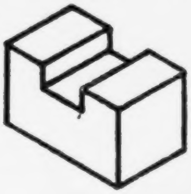
WORKBOOK SUPPLEMENT #11--Sketch an Isometric Drawing

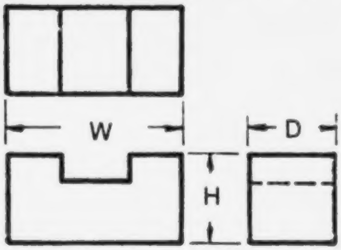
An isometric drawing provides a more lifelike view of a part than does an orthographic drawing. Isometric views are commonly used to illustrate aircraft repairs, and every good aviation technician should be able to sketch an isometric view.

This type of sketching can be drawn from an actual object or from any multiview drawing. An isometric sketch is drawn with both sides slanting back at a 30-degree angle. In sketching, this 30-degree angle is approximate. An isometric drawing can be sketched by using the procedure in the following example.

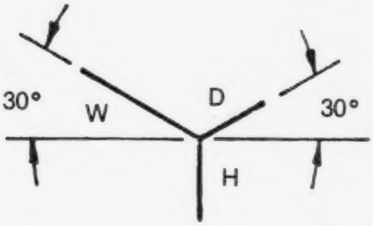
EXAMPLE:

1. Use actual object or multiview drawings and determine height, width, and depth.

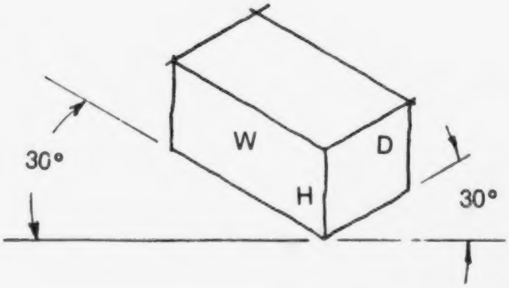




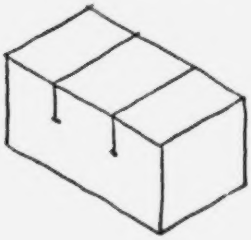
2. Lay off height, width, and depth as shown.



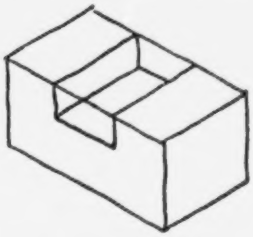
3. Box in the outline of the object.



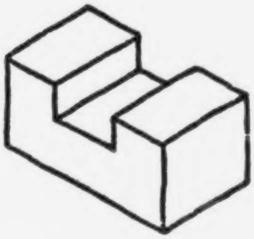
4. Locate object features such as slots, holes, and grooves.



5. Complete shape of object.

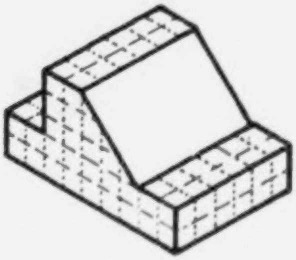


6. Erase construction lines and darken outline.



WORKBOOK SUPPLEMENT #11

Directions: Sketch an enlarged isometric of the object below. Drawing does not have to be drawn to scale.



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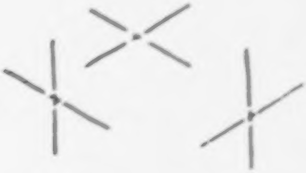
WORKBOOK SUPPLEMENT #12--Sketch Isometric Circles

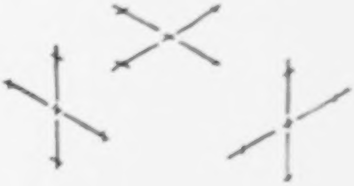
Circular curves are difficult to sketch accurately in an isometric view unless the aviation technician knows the proper steps. An isometric circle can be in the top, right side, or left side. In any case, the circle should always be boxed in and then its individual arcs sketched to make the complete isometric circle. Isometric circles can be sketched by using the procedure in the following example.

EXAMPLE:

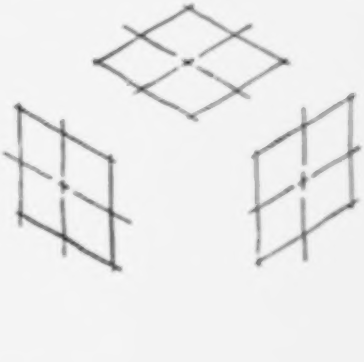
1. Lay out center lines.



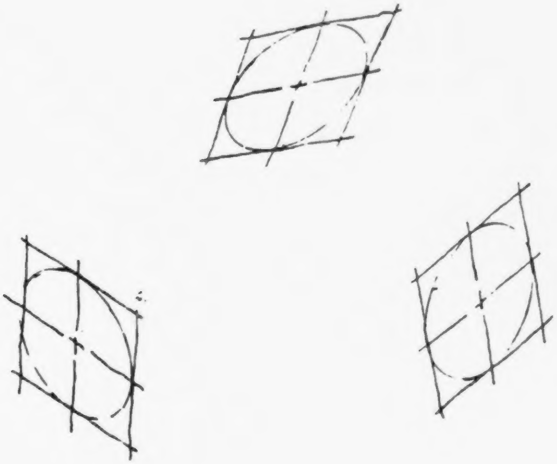
2. Mark off radius points.



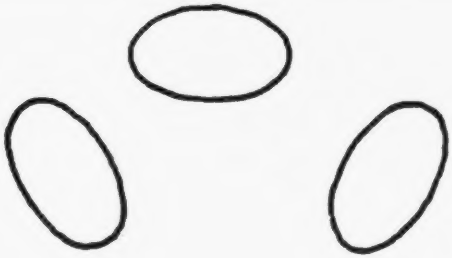
3. Box in circle outlines.



4. Sketch in arcs lightly.

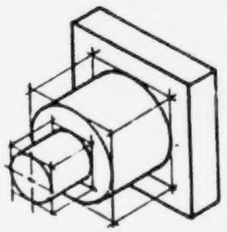


5. Erase construction lines and darken circles.



WORKBOOK SUPPLEMENT #12

Directions: Make enlarged isometric sketches in the space at the right of the object below. Drawing does not have to be drawn to scale.



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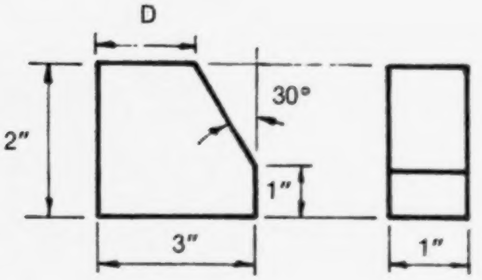
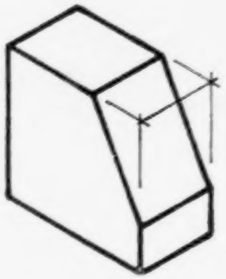
WORKBOOK SUPPLEMENT #13--Sketch Angles on an Isometric

Angles in an isometric sketch can be confusing unless the proper steps are followed in their construction. Use the procedure outlined in the following example to construct angles on an isometric. This workbook supplement will give you the opportunity to develop the competency you will need as an aviation technician in constructing angles on an isometric.

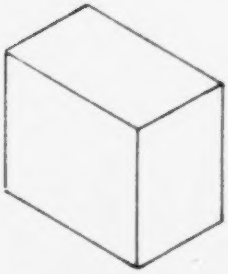
EXAMPLE:

(NOTE: The example will use the dimensions of the object on the left to construct the object on the right.)

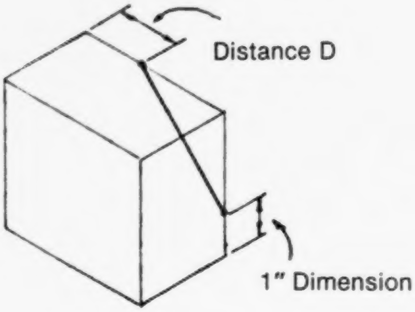




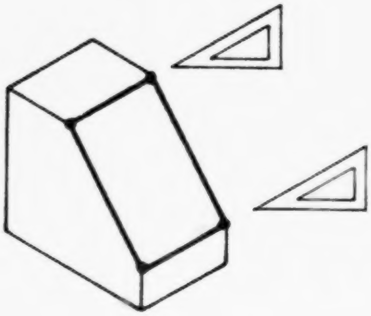
1. Box in overall dimensions of the object in isometric.



2. Lay out offset dimensions of angle and connect points.

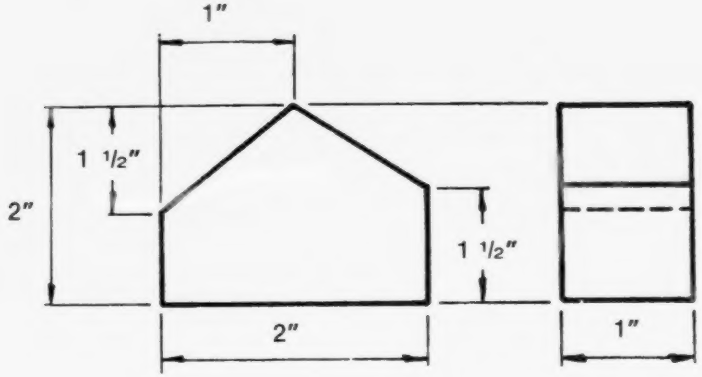

Distance D
1" Dimension

3. Complete the other side after extending lines.



WORKBOOK SUPPLEMENT #13

Directions: Construct the following object in isometric using the correct method to construct angles. Use top axis position and construct the long dimension to the left.



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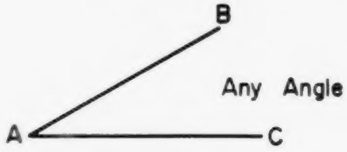
WORKBOOK SUPPLEMENT #14--Bisect an Angle

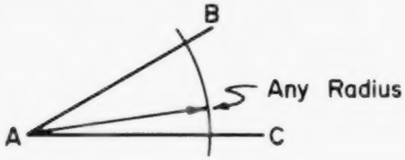
An angle can be bisected with a triangle and compass by using the procedure in the following example.

EXAMPLE:

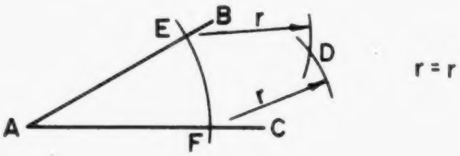
1. Use given angle BAC.



2. Strike a radius using a compass at any radius with point A.

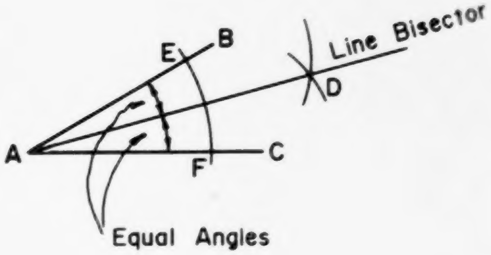


3. Strike equal arcs R with radius larger than half the distance from E to F.

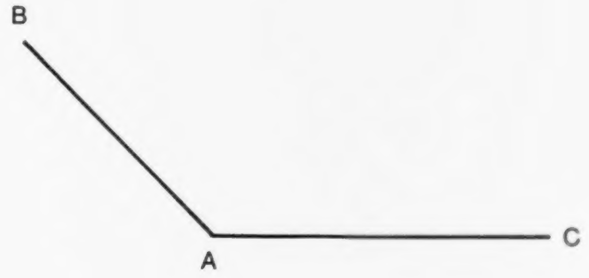


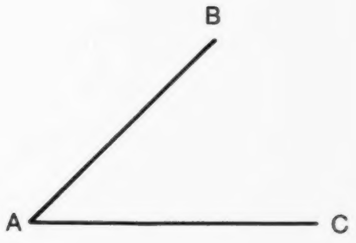
WORKBOOK SUPPLEMENT #14

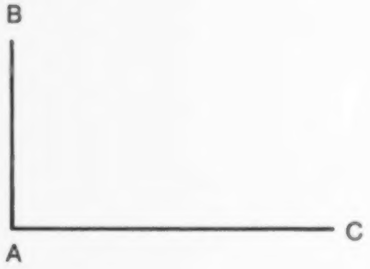
4. Draw a line from arc intersection D to point A.


E
B
Line Bisector
D
A
F
C
Equal Angles

Directions: Bisect the angles below. Leave all construction lines.







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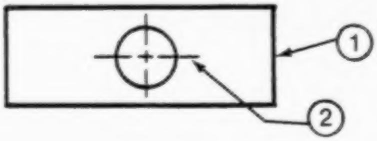
WORKBOOK SUPPLEMENT #15--Identify Types of Lines Commonly Found on Blueprints

The many different types of lines which make up an aircraft blueprint are very much like words in a sentence. Each line is weighted and formed to deliver a unique message. Together the lines convey information which enables the reader to correctly interpret the blueprint. This workbook supplement will give you the opportunity to further develop your competency in the identification of lines commonly found on blueprints.

Identify the following lines. Write the correct line names in the blanks. A drawing may have more than one type of line.

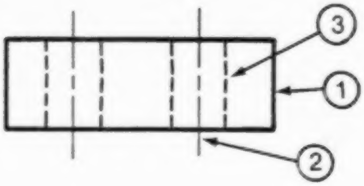
A.



1. ____

2. ____

B.

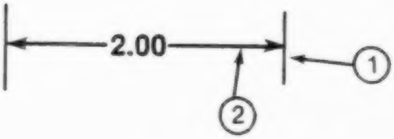


1. ____

2. ____

3. ____

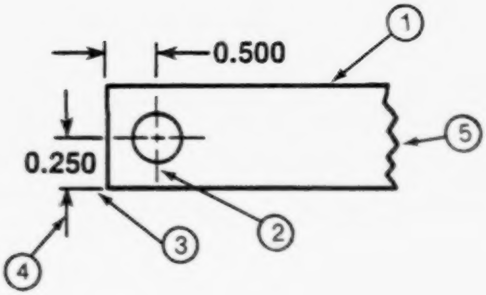
C.



1. ____

2. ____

D.


0.500
0.250
1
2
3
4
5

1. ______________________________

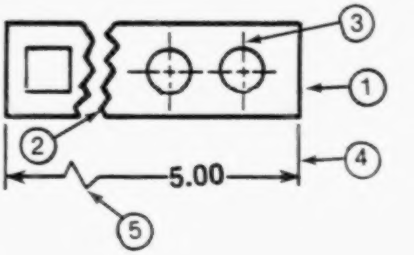
2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

E.



1. ______________________________

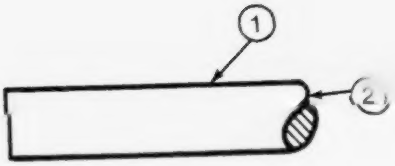
2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

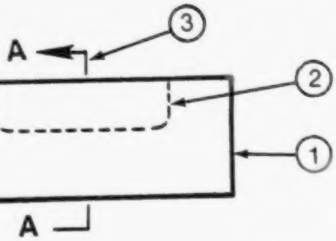
F.



1. ________________________________

2. ________________________________

G.

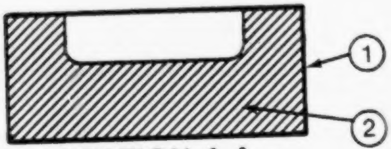


1. ________________________________

2. ________________________________

3. ________________________________

H.

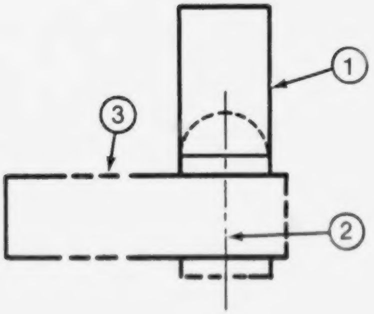


SECTION A-A

1. ________________________________

2. ________________________________

I.

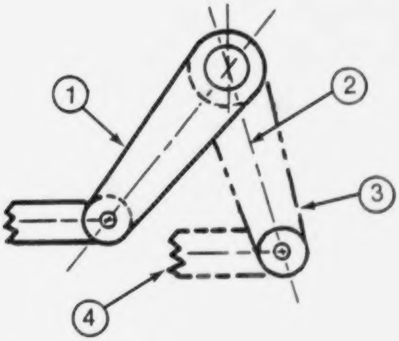


1. ______________________________

2. ______________________________

3. ______________________________

J.



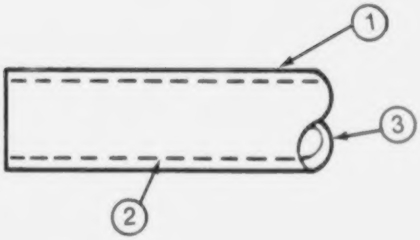
1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

K.

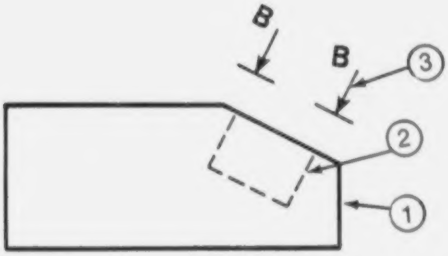


1. ____

2. ____

3. ____

L.

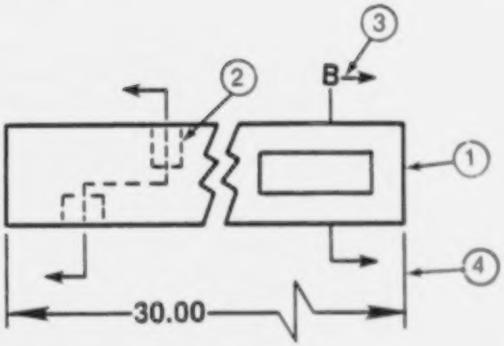


1. ____

2. ____

3. ____

M.



1. ____

2. ____

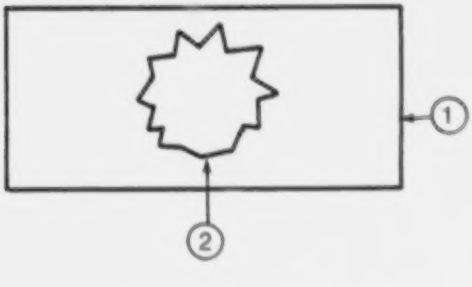
3. ____

4. ____

5. ____

6. ____

N.



1. ____

2. ____

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WORKBOOK SUPPLEMENT #16--Determine Dimensions on Blueprints

Blueprints are dimensioned so that the article pictured can be accurately reproduced by someone who most likely does not possess the original or has an original which has been damaged. The dimensions are clearly outlined on multiview orthographic drawings to enable the aviation maintenance technician to repair or replicate the part. This workbook supplement will allow you to develop competency in determining the dimensions on blueprints. Determine the dimensions on the following blueprint. Write the correct dimensions in the corresponding blanks on the following answer sheet.

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

H. ______________________________

J. ______________________________

K. ______________________________

L. ______________________________

M. ______________________________

N. ______________________________

P. ______________________________

Q. ______________________________

R. ______________________________

S. ______________________________

T. ______________________________

U. ______________________________

V. ______________________________

W. ______________________________

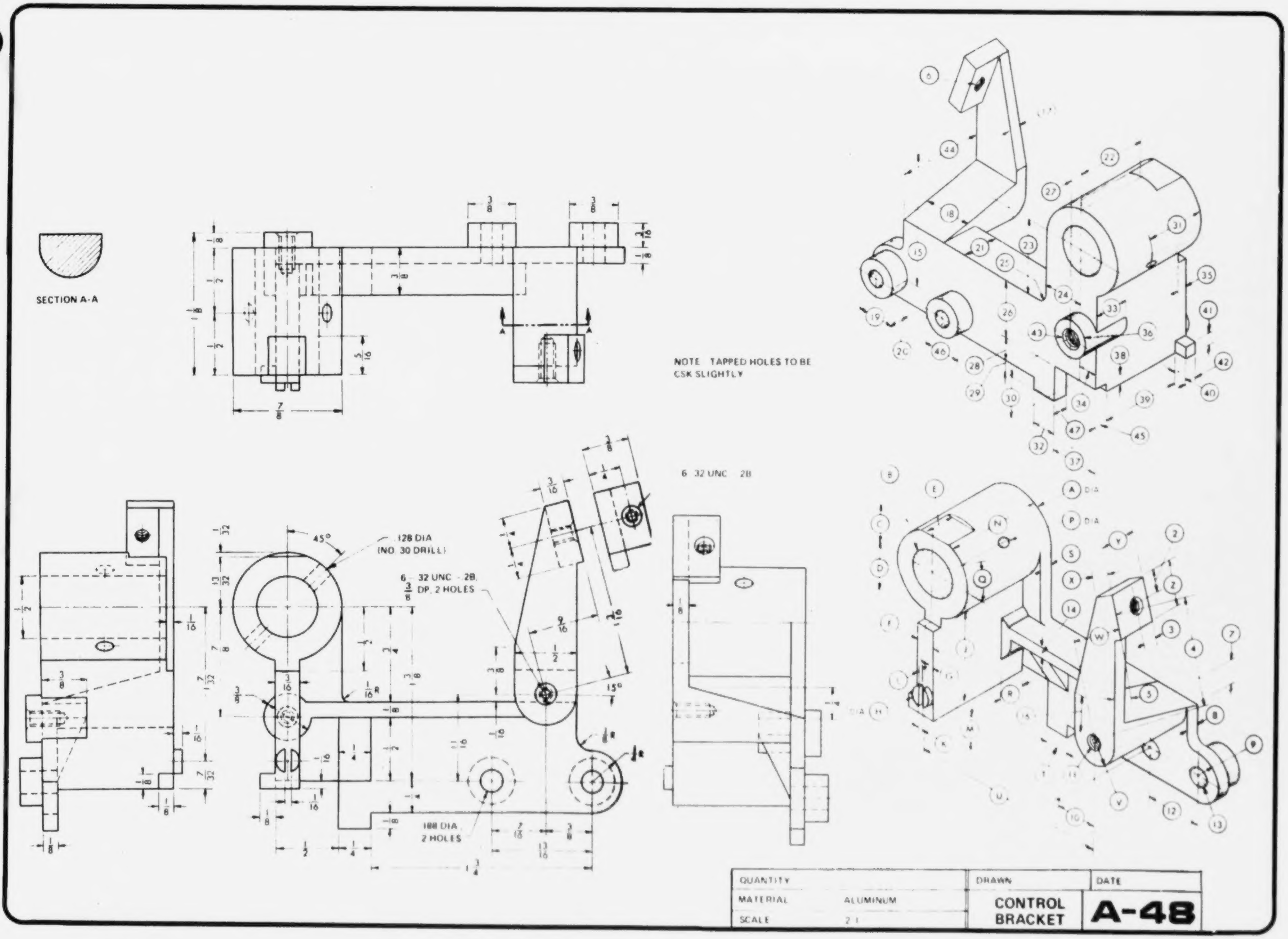
X. ______________________________

Y. ______________________________

Z. ______________________________

WORKBOOK SUPPLEMENT #16

2. ______________________
3. ______________________
4. ______________________
5. ______________________
6. ______________________
7. ______________________
8. ______________________
9. ______________________
10. ______________________
11. ______________________
12. ______________________
13. ______________________
14. ______________________
15. ______________________
16. ______________________
17. ______________________
18. ______________________
19. ______________________
20. ______________________
21. ______________________
22. ______________________
23. ______________________
24. ______________________
25. ______________________
26. ______________________
27. ______________________
28. ______________________
29. ______________________
30. ______________________
31. ______________________
32. ______________________
33. ______________________
34. ______________________
35. ______________________
36. ______________________
37. ______________________
38. ______________________
39. ______________________
40. ______________________
41. ______________________
42. ______________________
43. ______________________
44. ______________________
45. ______________________
46. ______________________
47. ______________________


SECTION A-A
NOTE TAPPED HOLES TO BE CSK SLIGHTLY
6-32 UNC-2B
.128 DIA (NO. 30 DRILL)
6-32 UNC-2B, 3/8 DP, 2 HOLES
45°
15°
.188 DIA, 2 HOLES
A DIA
P DIA
H DIA
QUANTITY
MATERIAL ALUMINUM
SCALE 2:1
DRAWN
DATE
CONTROL BRACKET
A-48

From: Interpreting Engineering Drawings, Delmar Publishers.

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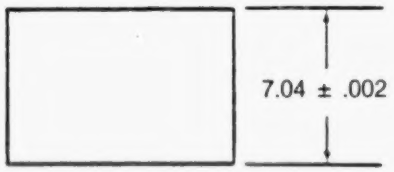
WORKBOOK SUPPLEMENT #17--Determine Tolerance Limits for Dimensions on Aircraft Drawings

The dimensions for any aircraft part reproduced from a blueprint are required to remain within a specific set of standards. These standards are called tolerances. The production of an aircraft part within its design tolerances will ensure that the part can be relied upon to fulfill its design goals for strength and serviceability. This workbook supplement will allow you to develop competency in determining tolerance limits for dimensions on aircraft drawings. Use the following drawings to answer the questions outlined in the workbook supplement.

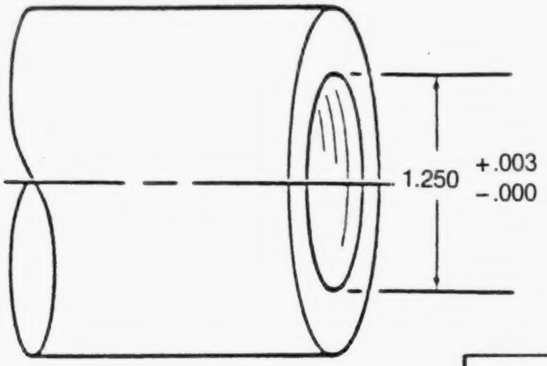
A. What is the tolerance of Part A? ____________________________

B. What are the limits of Part A? ______________________________

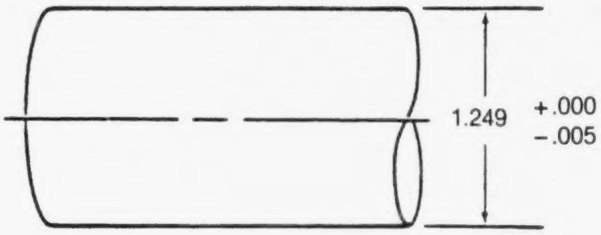


Part A

C. Using the information on the drawings of Parts B and C, complete the following table.



Part B



Part C

	Part B	Part C
Nominal Size		
Tolerance		
Limits		

WORKBOOK SUPPLEMENT #17

D. Using the information on the following Title Block Limits, determine the understood tolerances for the following dimensions. Write the correct tolerances in the blanks.

Tolerances Unless Otherwise Stated		
One place	.0	±.035
Two place	.00	±.030
Three place	.000	±.010
Four place	.0000	±.0005
Angles		±.0°30'

1. 8.17± ________________

2. 3.010± ________________

3. 4.15± ________________

4. 2.1± ________________

5. 1.253± ________________

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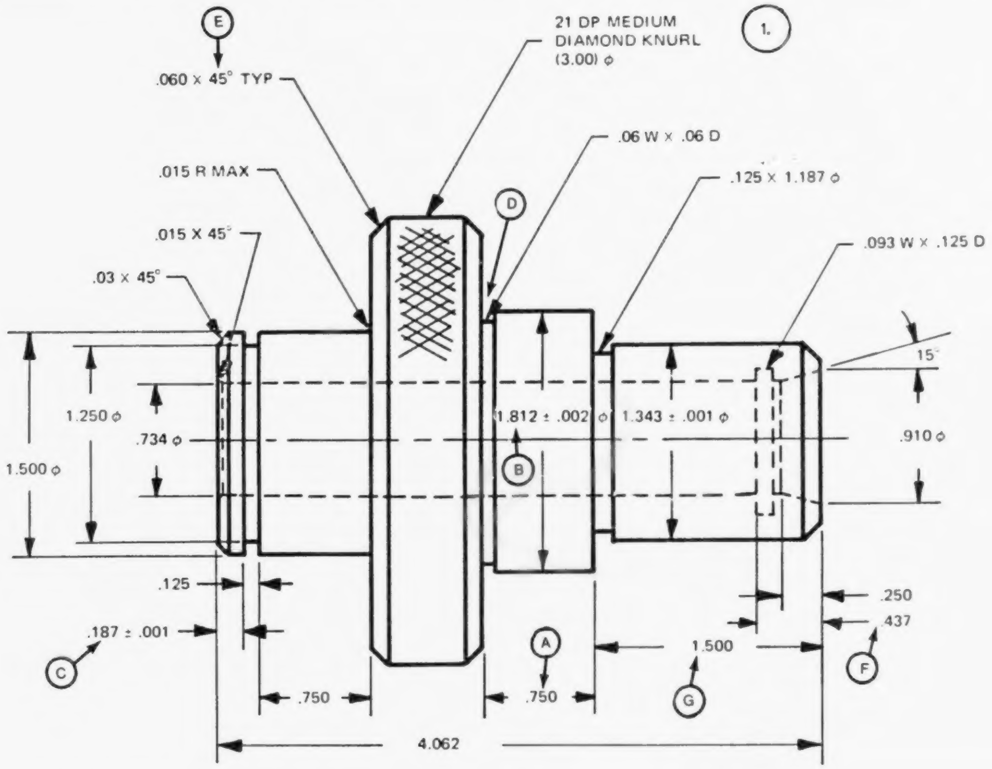
WORKBOOK SUPPLEMENT #17

E. Using the following drawing, determine tolerancing for the given dimensions. Write the correct answers in the blanks.


E
.060 x 45° TYP
21 DP MEDIUM DIAMOND KNURL (3.00) ϕ
1.
.06 W x .06 D
.015 R MAX
.125 x 1.187 ϕ
D
.015 X 45°
.093 W x .125 D
.03 x 45°
15°
1.250 ϕ
.734 ϕ
1.500 ϕ
1.812 ± .002 ϕ
1.343 ± .001 ϕ
.910 ϕ
B
.125
.250
.437
.187 ± .001
C
A
1.500
F
G
.750
.750
4.062

				TOLERANCE UNLESS OTHERWISE SPECIFIED	THIRD ANGLE PROJECTION	DWN. BY	SIGN.	DATE	PART NAME
				.00 = ± .010			TBJ	6 30	SHAFT
				.000 = ± .005		CHK. BY	RAK	7 2	PART NO. 50009
1	21 DP WAS 14 DP	11/11	RDA	ANGLES ± 0°30'	SCALE FULL	FINISH 125✓			MATERIAL 1117 STL · QUANTITY 750
NO	CORRECTIONS	DATE	APPD						

Robert A. Yearling, Machine Trades Blueprint Reading, © 1983, p. 120. Reprinted by permission of Prentice-Hall, Englewood Cliffs, New Jersey.

1. What will the dimension limits be at letter "A"? ____________
2. What is the tolerance for the dimension at letter "B"? ________
3. What are the dimension limits at letter "C"? ________________
4. What is the tolerance and limits for the groove's width and depth at letter "D"? ______________________________

5. What is the tolerance given for the angle at letter "E"?

____

6. What are the dimension limits at letter "F"? ____________________

7. What are the dimension limits at letter "G"? ____________________

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WORKBOOK SUPPLEMENT #18--Interpret Information on a Graph

An aviation maintenance technician relies upon the manufacturer to supply data which will facilitate maintenance and repair of an aircraft or an aircraft component. The manufacturer relies upon the skill of the technician when the data must be extracted and used. Some data is supplied to the technician in the form of graphs. These graphs will give the technician immediate access to maintenance information, provided the graph is interpreted properly. This workbook supplement will give you the opportunity to develop competency in interpreting the information on a graph.

Using Figure 1-36 in EA-ITP-C 4:I:25, answer the following questions. Write the correct answers in the blanks.

A. What size wire will be needed to carry 80 amps for 75 feet in a 14-volt system? ____

B. What is the maximum length of a 4-gage wire carrying 90 amps in a 28-volt system? ____

C. What size wire can be used if it is to carry an intermittent current of 50 amps a distance of 90 feet in a 200-volt system? ______________________

D. What size wire would be used to carry 2 amps for 30 feet continuous in a bundle on a 14-volt system? ____

E. What size wire would be used to carry 20 amps for 40 feet single wire in free air in a 115-volt system? ____

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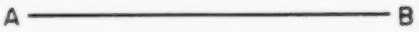
WORKBOOK SUPPLEMENT #19--Draw Parallel Lines

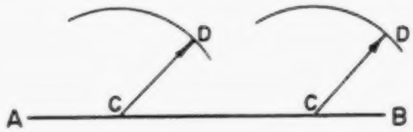
Parallel lines can be drawn with a triangle, compass, and scale by using the procedure in the following example.

EXAMPLE:

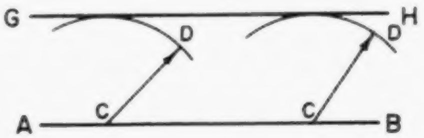
1. Use given line AB.



2. Set compass any desired radius CD and swing two arcs anywhere along AB.

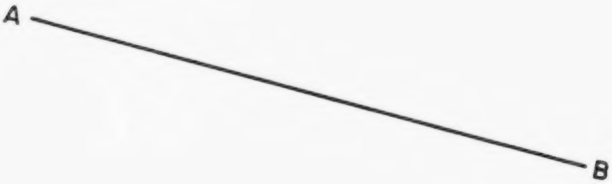


3. Construct line GH tangent to arcs CS (radius CD required distance between parallel lines).



WORKBOOK SUPPLEMENT #19

Directions: Construct a line parallel to line AB and 1" below line AB. Leave all construction lines.



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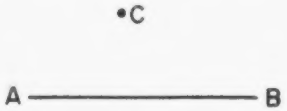
WORKBOOK SUPPLEMENT #20--Construct a Perpendicular Line To a Line From a Point

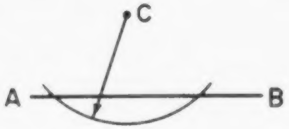
A perpendicular line can be constructed to a line from a point with a triangle and compass. Using the procedure in the following example, construct a perpendicular line from a point.

EXAMPLE:

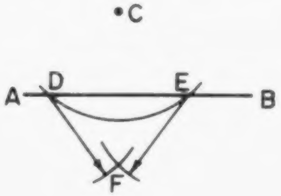
1. Use given line AB and point C.



2. Swing any radius from point C as long as it touches two points on line AB.



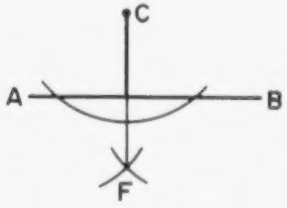
3. Swing radius DF and radius FF equal to radius DC.



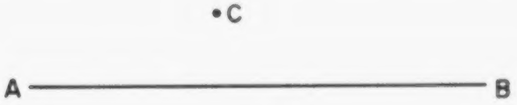
WORKBOOK SUPPLEMENT #20

4. Connect point C with point F.

(NOTE: Line CF is 90° to line AB.)



Directions: Construct a line perpendicular from point C to line AB. Leave all construction lines.



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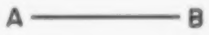
WORKBOOK SUPPLEMENT #21--Divide a Line into Equal Parts

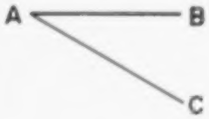
A line can be divided into equal parts with a 45°, 30°, and 60° triangle and a scale by using the procedure in the following example.

EXAMPLE:

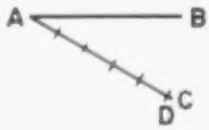
1. Divide given line AB into five equal parts.



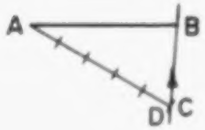
2. From Point A, draw a line at any angle and any length and label point C.



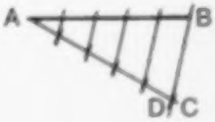
3. Use scale to lay off five equal divisions on line AC; label the last division.



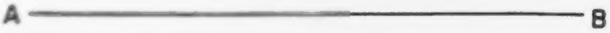
4. Set triangle to project division back to line AB from point D.



5. Set triangle to be parallel to line BD; mark divisions on line AB parallel to line BD.



Directions: Divide AB into seven equal divisions. Leave all construction lines.



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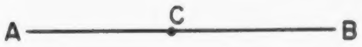
WORKBOOK SUPPLEMENT #22--Draw a Line Perpendicular Through a Point on a Line

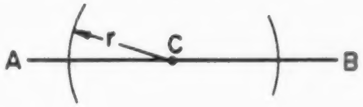
A line can be drawn perpendicularly through a point on a line with a triangle, compass, and scale by using the procedure in the following example.

EXAMPLE:

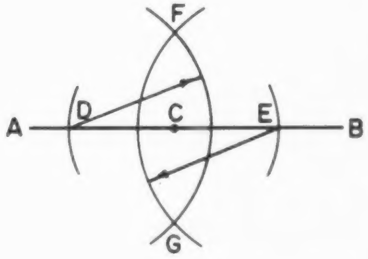
1. Use given line AB with point C located on line AB.



2. Set compass at any radius R and swing arc through line AB from point C.



3. Set compass at distance greater than DC and swing arcs from D and E to form points F and G.



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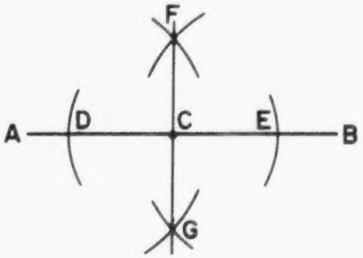
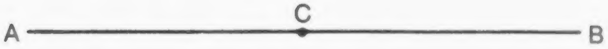
4. Connect points F and G through C.



Directions: Draw a line perpendicular through point C on line AB. Leave all construction lines.



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G102-C

WORKBOOK SUPPLEMENT #23--Interpret an Aircraft Drawing

As an aviation maintenance technician, you will be required to have a high degree of competency in interpreting aircraft drawings. This workbook supplement will give you the opportunity to further develop your competency in the interpretation of aircraft drawings. Interpret the following drawing to answer the questions. Write the correct answers in the blanks.

(NOTE: The C75, C85, C90, and O-200 series engines are no longer in production and are found mostly in antique and sport aircraft. These engines have had distinguished service lives and continue to keep airplanes flying today. These drawings were selected for this workbook supplement because it is an excellent example of multiview orthographic installation drawing which will provide you with a great amount of information in an organized manner.)

A. How much room is required to remove the Delco-Remy starter and the Delco-Remy generator when the engine is installed in the aircraft?

   1. Generator ______________________________

   2. Starter ______________________________

B. What are the limits established for the prop bolt holes in the Series 12F flanged crankshaft? ______________________________

C. What is the tolerance for the center-to-center dimension given for the exhaust port holes? ______________________________

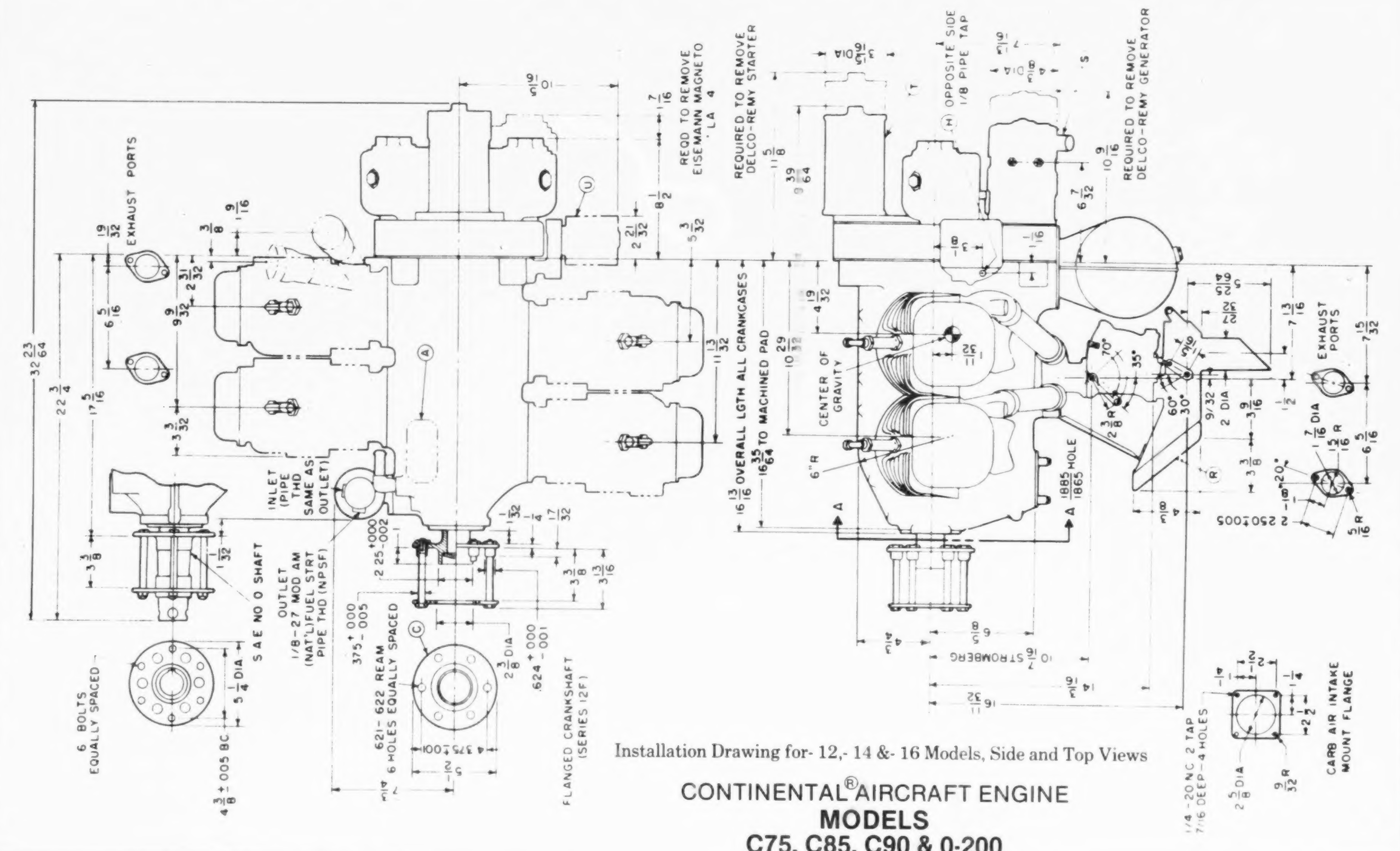
D. What type of lines are used to depict the oil fill tube on the oil tank in the top view? ______________________________

E. What is the overall length of all crankcases? ______________________________

F. What tap should be used on the holes in the carburetor air intake mount flange? ______________________________

G. How far is the center-of-gravity located beneath the centerline of the crankshaft? ______________________________

H. How many bolts are in the tapered propeller shaft installation? ________


EXHAUST PORTS
REQD TO REMOVE EISEMANN MAGNETO LA 4
REQUIRED TO REMOVE DELCO-REMY STARTER
(H) OPPOSITE SIDE 1/8 PIPE TAP
REQUIRED TO REMOVE DELCO-REMY GENERATOR
CENTER OF GRAVITY
16 13/16 OVERALL LGTH ALL CRANKCASES
16 35/64 TO MACHINED PAD
INLET (PIPE THD SAME AS OUTLET)
OUTLET 1/8-27 MOD AM (NAT'L) FUEL STRT PIPE THD (NPSF)
S A E NO 0 SHAFT
6 BOLTS EQUALLY SPACED
4 3/8 ± .005 BC
5 1/4 DIA
.621-.622 REAM 6 HOLES EQUALLY SPACED
FLANGED CRANKSHAFT (SERIES 12F)
10 7/16 STROMBERG
1885/1865 HOLE
6" R
CARB AIR INTAKE MOUNT FLANGE
1/4-20 NC 2 TAP 7/16 DEEP-4 HOLES
32 23/64
22 3/4
17 5/16

Installation Drawing for- 12,- 14 &- 16 Models, Side and Top Views

CONTINENTAL® AIRCRAFT ENGINE

MODELS

C75, C85, C90 & 0-200

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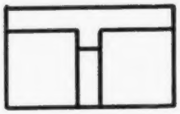
GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
G102-C

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #1

A.



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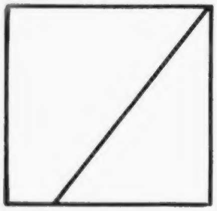

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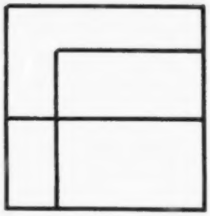
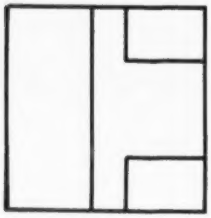
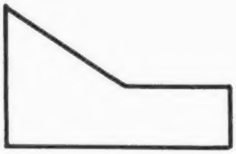


D.

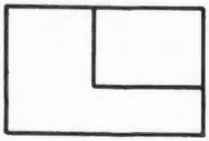


Workbook Supplement #2

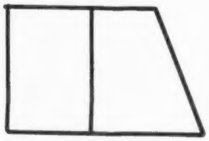
A.



B.



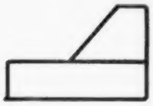
C.



ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #3

A.



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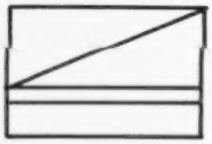

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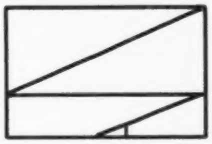

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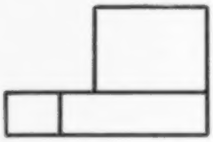
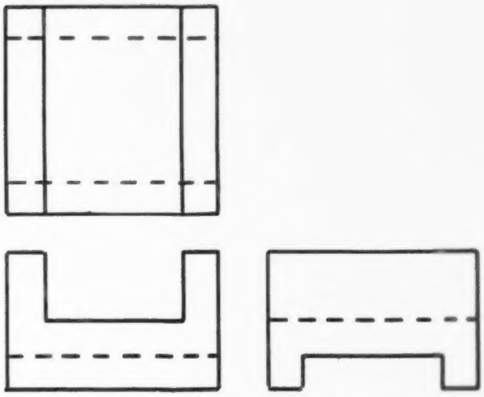


Workbook Supplement #4

A.



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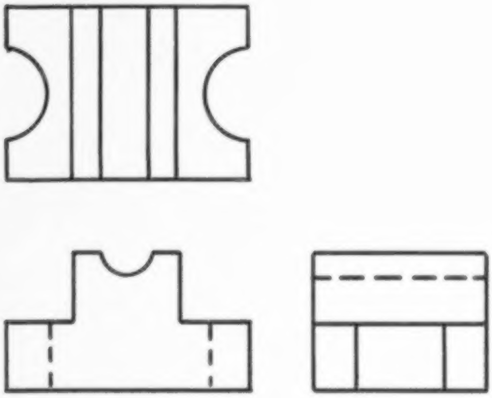

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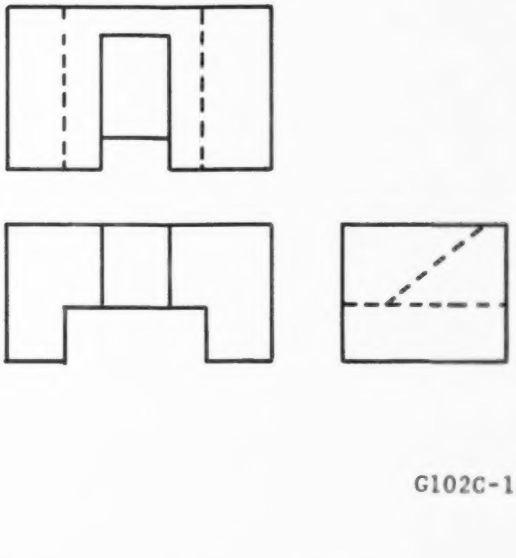

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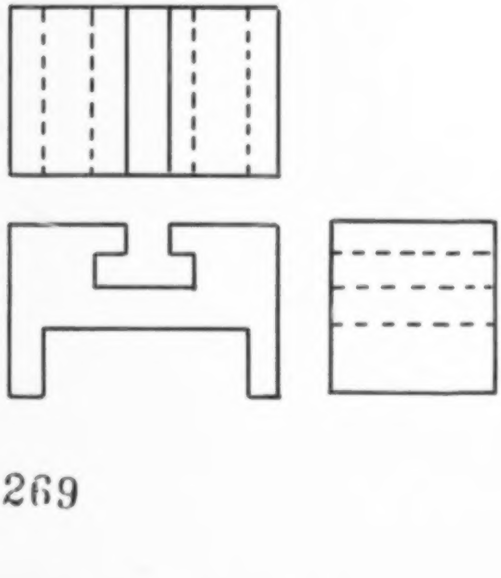
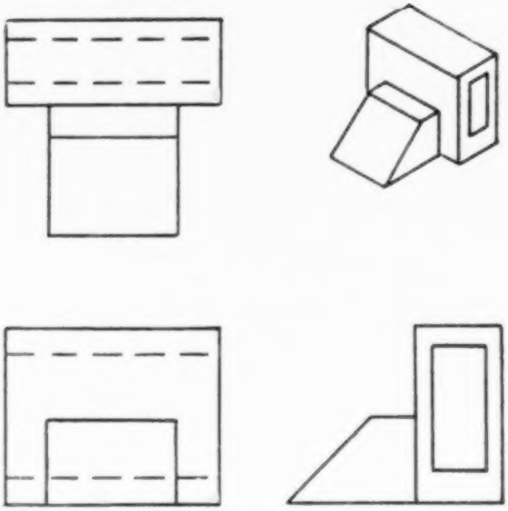


ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #5

A.



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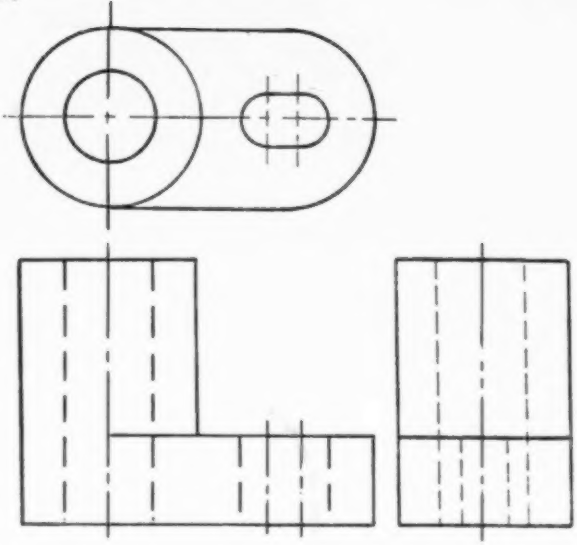

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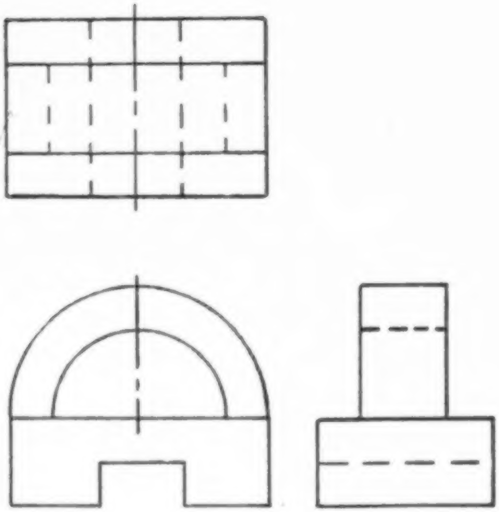

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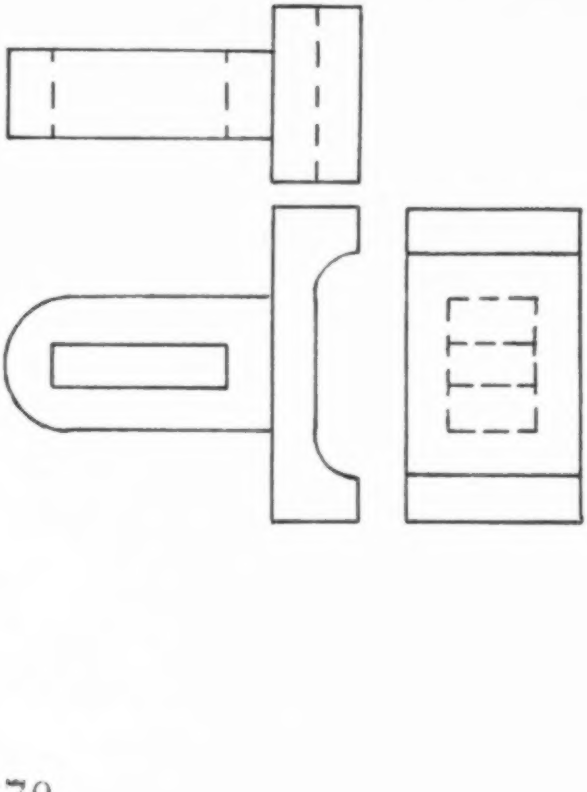
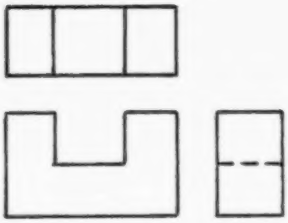


ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #5 (Continued)

E.



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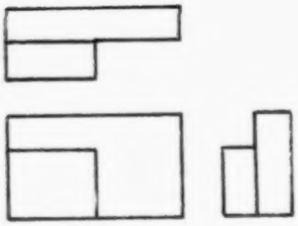
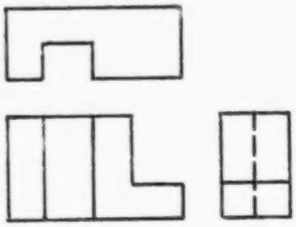


G.



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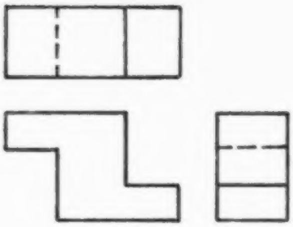
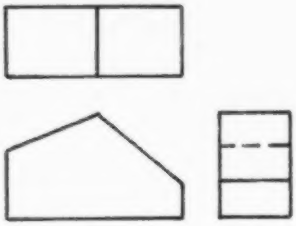


I.



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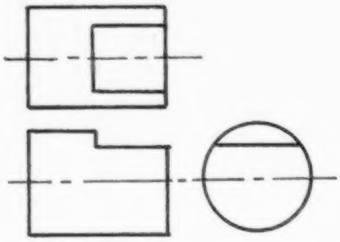

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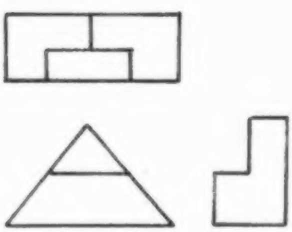

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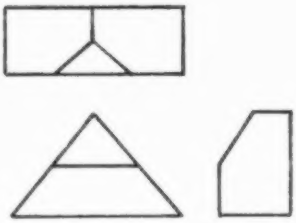
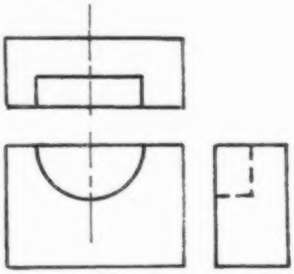


M.



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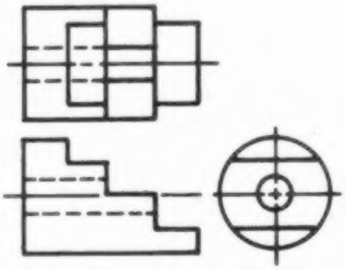
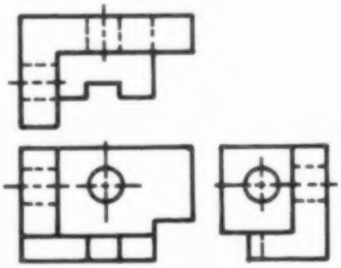


O.



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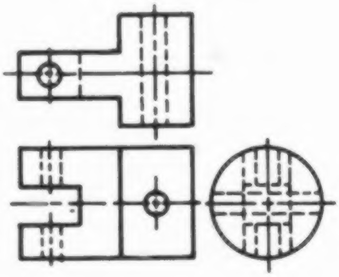


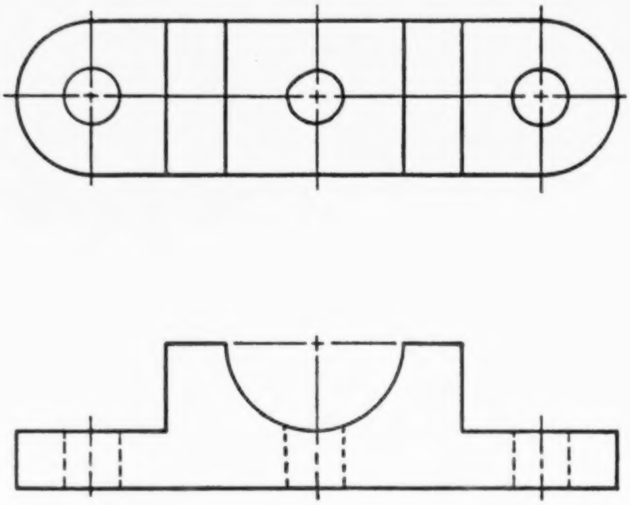
ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #6--Evaluated to the satisfaction of the instructor

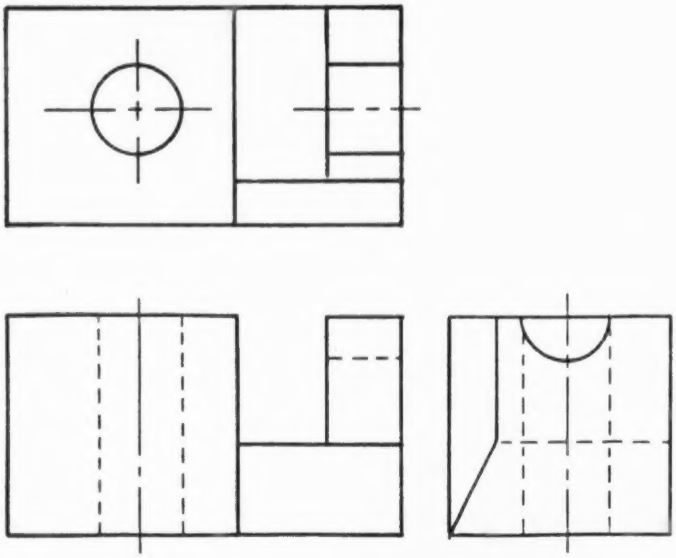
Workbook Supplement #7--Evaluated to the satisfaction of the instructor

Workbook Supplement #8--Evaluated to the satisfaction of the instructor

Workbook Supplement #9

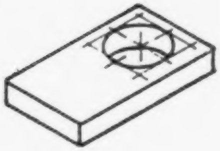


Workbook Supplement #10

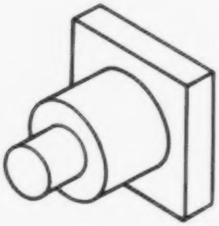


ANSWERS TO WORKBOOK SUPPLEMENTS

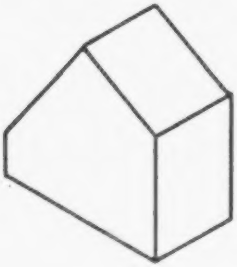
Workbook Supplement #11



Workbook Supplement #12



Workbook Supplement #13



ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #14--Evaluated to the satisfaction of the instructor

Workbook Supplement #15

A. 1. Visible lines
    2. Centerlines

B. 1. Visible lines
    2. Centerlines
    3. Hidden lines

C. 1. Extension lines
    2. Dimension lines

D. 1. Visible lines
    2. Centerlines
    3. Extension lines
    4. Dimension lines
    5. Break line (short)

E. 1. Visible lines
    2. Break lines (short)
    3. Centerlines
    4. Extension lines
    5. Confined dimension lines

F. 1. Visible lines
    2. Cylindrical break line (solid)

G. 1. Visible lines
    2. Hidden lines
    3. Cutting plane

H. 1. Visible lines
    2. Section lines

I. 1. Visible lines
    2. Centerlines
    3. Phantom lines

J. 1. Visible lines
    2. Centerlines
    3. Alternate position lines
    4. Break lines (short)

K. 1. Visible lines
    2. Hidden lines
    3. Cylindrical break lines

L. 1. Visible lines
    2. Hidden lines
    3. Viewing plane lines

M. 1. Visible lines
    2. Hidden lines
    3. Cutting plane lines
    4. Extension lines
    5. Confined dimension lines
    6. Break lines (long)

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #16

A. 7/8
B. 1/2
C. 13/32
D. 1/2
E. 5/16
F. 3/16
G. 1/16
H. 3/16
J. 15/16
K. 1/16
L. 1/16
M. 5/15
N. 1.00
P. 0.128
Q. 45°
R. 1/4
S. 1/8
T. 1/4
U. 2 1/32
V. 1/4
W. 9/16
x. 3/16
Y. 3/8
Z. 1/2

2. 1/4
3. 1/8
4. 1 3/16
5. 15°
6. 6-32 UNC 2B tap hole
7. 1/4
8. 1/8
9. 1/4R
10. 7/16
11. 6-32 UNC-2B tap hole 3/8 dp
12. 13/16
13. 0.188 dia.
14. 1/8
15. 1 3/8
16. 3/8
17. 1/8
18. 1/2
19. 3/8
20. 3/16
21. 3/8
22. 11/16
23. 3/4
24. 7/16

25. 1/16R
26. 5/8
27. 1/8
28. 1/4
29. 1/8
30. 1/2
31. 1/2
32. 1/4
33. 3/8
34. 3/32
35. 1/16
36. 3/16R
37. 1/2
38. 1/8
39. 3/4
40. 1/8
41. 1/8
42. 1/8
43. 6-32 UNC 2B tap hole 3/8 dp
44. 7/8
45. 1/8
46. 3/8
47. 1/8

ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #17

A. ±0.002

B. 7.038 - 7.042

C.

	Part	
	B	C
Nominal Size	1.250	1.249
Tolerance	+.003 -.000	+.000 -.005
Limits	1.250	1.244
	1.253	1.249

D. 1. 8.14 - 8.20
   2. 3.000 - 3.020
   3. 4.12 - 4.18
   4. 2.064 - 2.135
   5. 1.1248 - 1.1258

E. 1. 0.74 - 0.76
   2. ±0.002
   3. 0.186 - 0.188
   4. 0.010/0.05 - 0.07
   5. ±0° / 30 minutes
   6. 0.42 - 0.44
   7. 1.495 - 1.505

Workbook Supplement #18

A. 3/0 wire
B. 40 feet
C. 10 gage wire
D. 18 gage wire
E. 16 gage wire

Workbook Supplement #19--Evaluated to the satisfaction of the instructor

Workbook Supplement #20--Evaluated to the satisfaction of the instructor

ANSWERS TO WORKBOOK SUPPLEMENT

Workbook Supplement #21--Evaluated to the satisfaction of the instructor

Workbook Supplement #22--Evaluated to the satisfaction of the instructor

Workbook Supplement #23--

A. 1. 10 9/16
   2. 11 5/8

B. 0.621 - 0.622
C. ±0.005
D. Phantom lines
E. 16 13/16
F. 1/4 - 20NC
G. 1 11/32
H. 6

GENERAL
G012 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
G102-C

THEORY TEST

1. Match terms related to blueprints and drawings to their correct definitions. Write the correct numbers in the blanks.

___a. Drawing that shows all parts in an assembly in their relative positions, but expanded outward so that each can be identified

___b. Drawing of a single part, drawn to scale with all dimensions and details necessary to make the part in the shop

___c. Diagram of an electrical or hydraulic system using line drawings of components rather than conventional symbols; used to help visualize operation of a system

___d. Drawing composed of up to six views of an object as they would appear if projected onto the surfaces of a transparent box enclosing the object; usually depicts one, two, or three views

___e. Number assigned to drawing of aircraft part; becomes permanent part number

___f. Portions of a roll-size aircraft drawing indicated by letters along the vertical edges and numbers along the horizontal edges

___g. Drawing that references detail parts by part numbers and specifies types and number of fasteners to be used to join them into subassemblies; includes only those dimensions needed for assembly

___h. Diagram that identifies all wires, components, and uses of wires in a circuit

1. Drawing number
2. Exploded view
3. Pictorial electrical diagram
4. Detail drawing
5. Orthographic drawing
6. Assembly drawing
7. Zones
8. Electrical wiring diagram

____i. Drawing that shows how parts or subassemblies are installed on aircraft, including information on fasteners, adjacent parts, or adjustments

____j. Record of all necessary manufacturer's information; printed in lower right-hand corner of every aircraft drawing

____k. Medium or heavyweight dashed line used to show the plane at which a sectional view is constructed; arrowheads show directions in which the view is seen

____l. Lines used to indicate a cross-section, to denote material of which a part is made, or to distinguish between pieces of material

____m. Drawing that shows internal construction or shape of a part by means of a cross-section, half section, revolved, or removed part

____n. Diagram used to explain a principle of operation, rather than to show parts as they actually appear

____o. Directs troubleshooting steps in a logical, step-by-step manner, identifying probable faults in a system and specifying repair for each one

____p. Diagram showing blocks representing many components, designed to show operations rather than individual parts

____q. Projection of a three-dimensional object onto a flat plane, with the object rotated so that three of its faces are visible and the angles between each of the sides are equal

____r. Indication of precise measurements on a drawing with reference to datum edges or surfaces

9. Installation drawing
10. Cutting-plane line
11. Title block
12. Schematic diagram
13. Block diagram
14. Logic flowchart
15. Sectional drawing
16. Section lines
17. Dimensioning
18. Isometric drawing

___s. Projection of a three-dimensional object onto a flat plane, with the object rotated so that three of its faces are visible, with one face parallel to the plane of the drawing

___t. Precision with which a part is to be made

___u. Light solid lines used to show exact locations of dimensions, with arrowheads at each end and broken in the center for dimension to be inserted

___v. Light lines made up of long dashes alternating with two short dashes; used to indicate presence of another part included for reference only, or for alternate position of a part

___w. Sketch that shows location of a repair, types of materials used, and enough detail so repair can be duplicated

___x. Medium-weight dashed lines that show edges that cannot be seen in a view of a part

___y. Drawing in which rays projecting from the object intersect at a vanishing point on the horizon

___z. Locations fore and aft along the fuselage of an aircraft; measured from a datum called station zero

___aa. Indication, in inches, of distances from the fuselage centerline outward along the wing toward the tip

___bb. Medium-weight solid lines that show edges that are seen in the view of a part

___cc. Light lines, with arrowheads, that extend from a note to a part of the drawing to which the note applies

19. Repair sketch
20. Dimension lines
21. Oblique drawing
22. Tolerance
23. Hidden lines
24. Perspective drawing
25. Phantom lines
26. Leader lines
27. Fuselage stations
28. Visible lines
29. Wing stations

THEORY TEST

____dd. Indication, in inches, of distances to the right or left of the centerline of the fuselage

____ee. Alternate long- and short-dashed lines that show centers of holes or of symmetrical parts

____ff. Lines used across a dimension of a part which continues but is of no concern in that particular drawing

____gg. Vertical measurements made on an aircraft with reference to a line called water line zero

____hh. Light lines extending from edges of points at which measurements are made

30. Break lines
31. Center lines
32. Water lines
33. Extension lines
34. Buttock lines

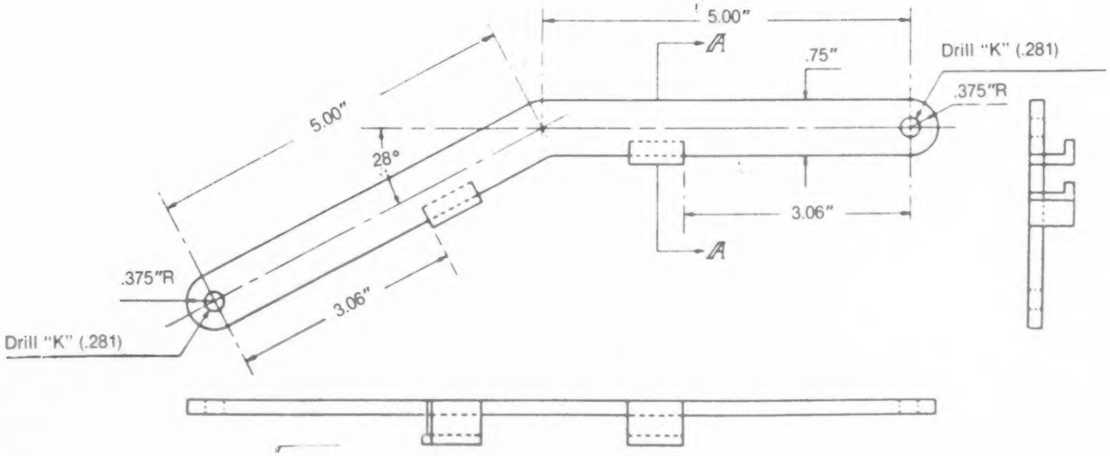
2. Identify the following types of aircraft drawings by placing an "X" in the correct blanks.

a. _____1) Assembly

_____2) Sectional

_____3) Exploded-view

_____4) Detail


5.00"
A
.75"
Drill "K" (.281)
.375"R
5.00"
28°
3.06"
A
.375"R
3.06"
Drill "K" (.281)

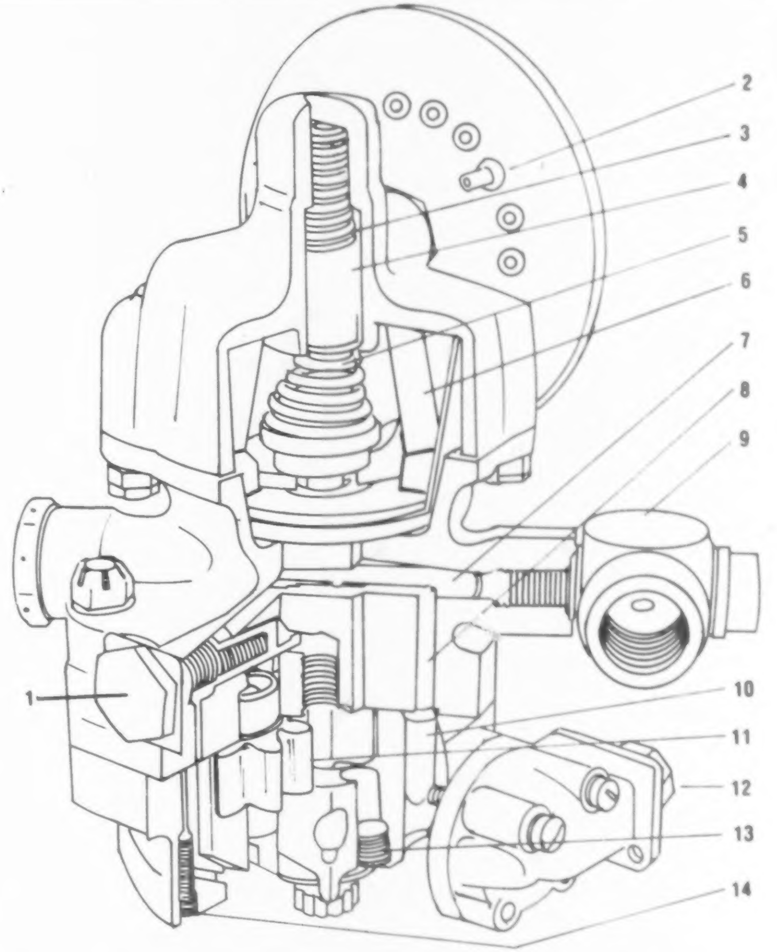
Material — Steel

b. _____1) Detail

_____2) Assembly

_____3) Exploded-view

_____4) Installation



1. Relief Valve
2. Pulley Stop Pin
3. Balance Spring
4. Rack Assembly
5. Speeder Spring
6. Fly-Weight
7. Transfer Valve Plunger
8. Propeller Oil Passage
9. Swivel Fitting
10. Propeller Oil Strainer
11. Pump Idler Gear
12. Cutout Switch
13. Base Oil Control Plug
14. Dump Valve

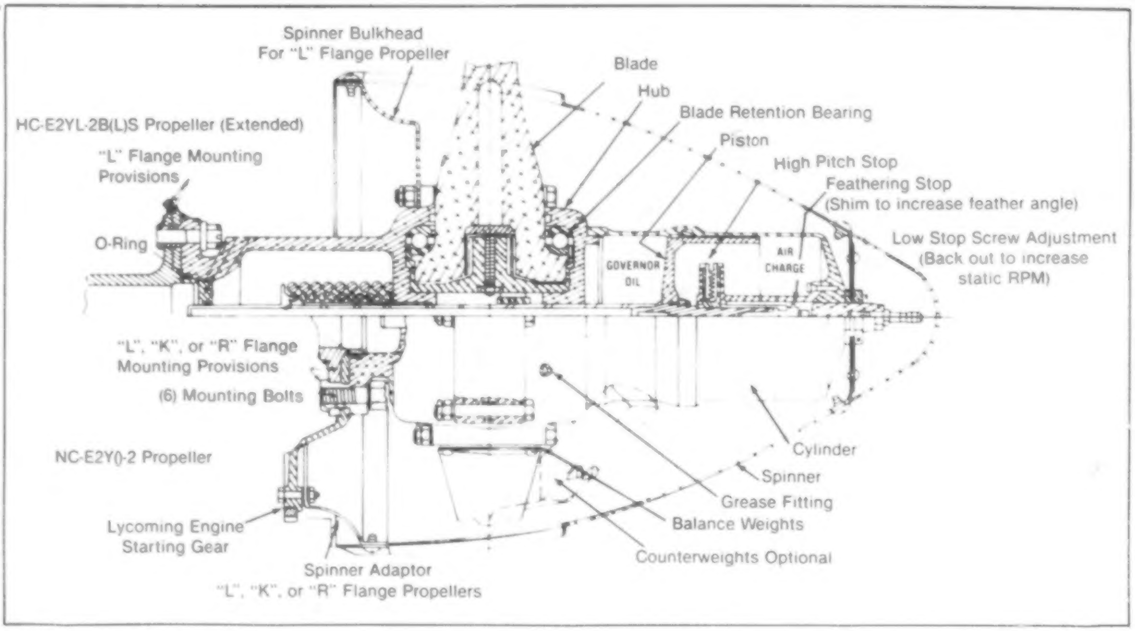
THEORY TEST

c. ____1) Exploded-view

____2) Detail

____3) Sectional

____4) Installation


Spinner Bulkhead
For "L" Flange Propeller
Blade
Hub
Blade Retention Bearing
HC-E2YL-2B(L)S Propeller (Extended)
Piston
High Pitch Stop
"L" Flange Mounting
Provisions
Feathering Stop
(Shim to increase feather angle)
O-Ring
GOVERNOR
OIL
AIR
CHARGE
Low Stop Screw Adjustment
(Back out to increase
static RPM)
"L", "K", or "R" Flange
Mounting Provisions
(6) Mounting Bolts
Cylinder
NC-E2Y()-2 Propeller
Spinner
Grease Fitting
Lycoming Engine
Starting Gear
Balance Weights
Counterweights Optional
Spinner Adaptor
"L", "K", or "R" Flange Propellers

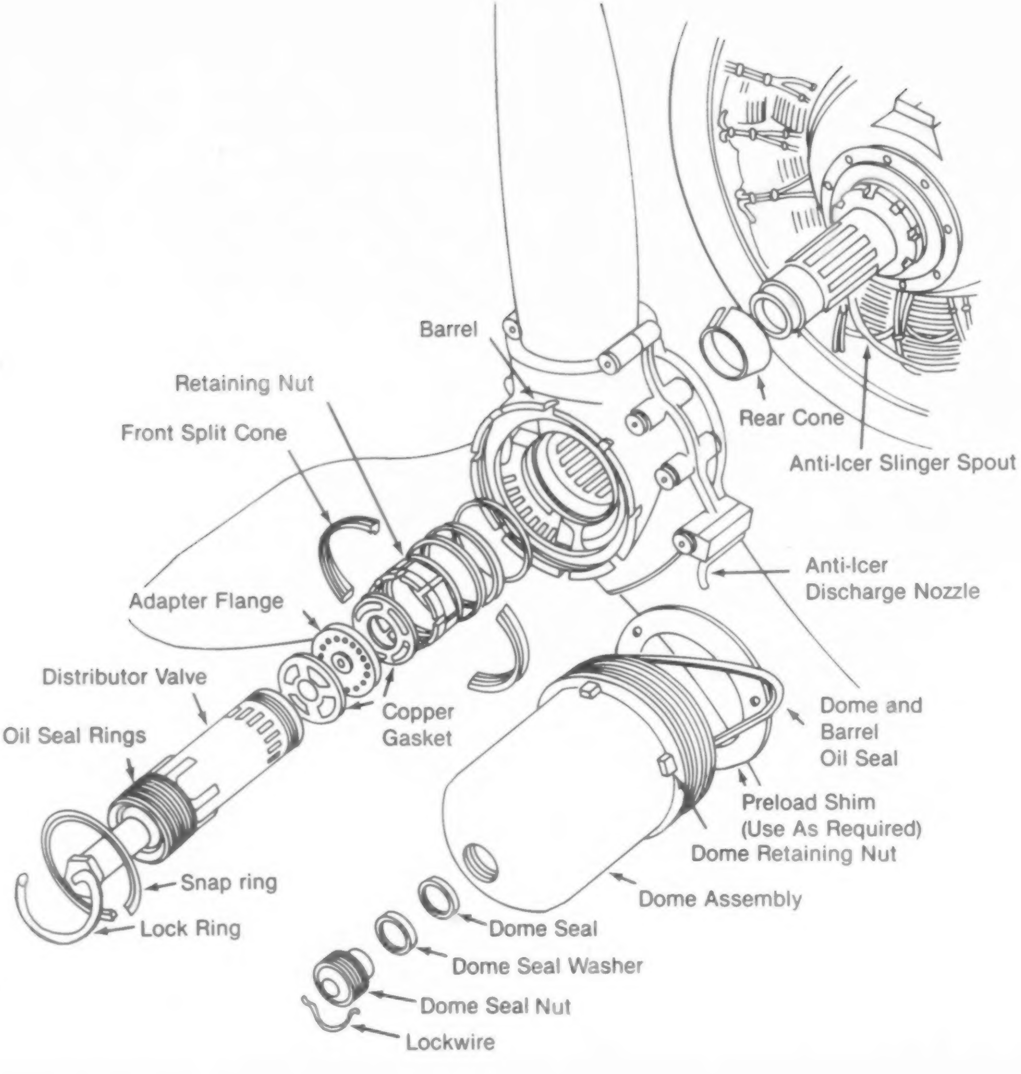
THEORY TEST

d. _____1) Sectional

_____2) Detail

_____3) Exploded-view

_____4) Installation

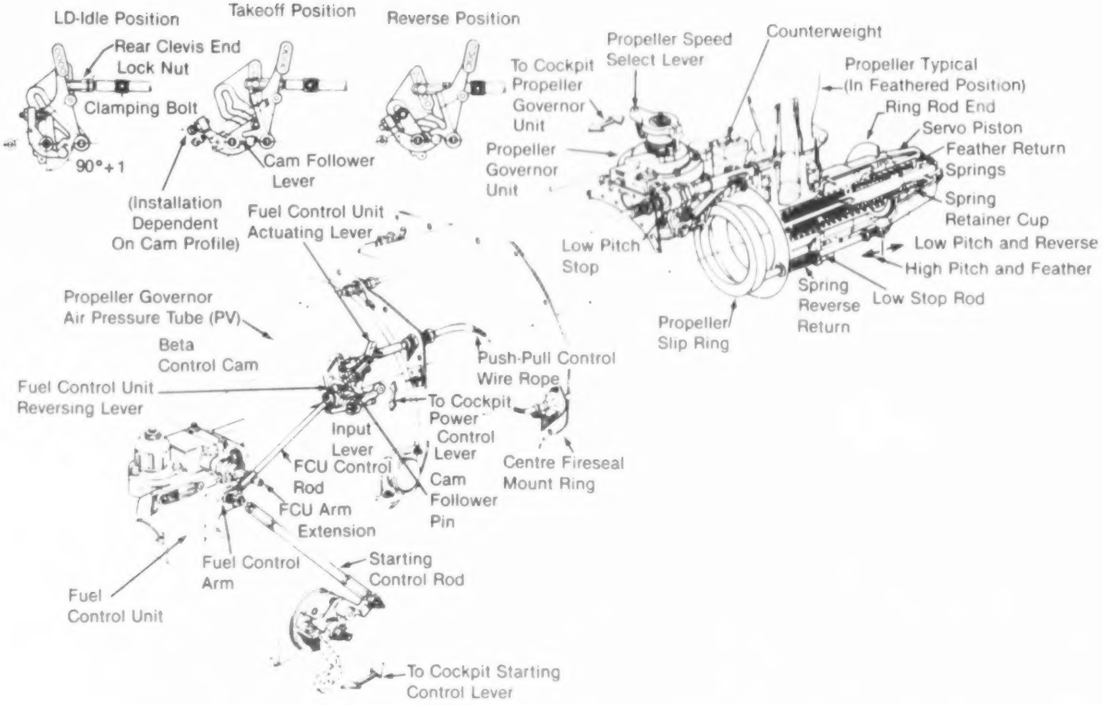

Barrel
Retaining Nut
Front Split Cone
Rear Cone
Anti-Icer Slinger Spout
Anti-Icer Discharge Nozzle
Adapter Flange
Distributor Valve
Copper Gasket
Oil Seal Rings
Dome and Barrel Oil Seal
Preload Shim (Use As Required)
Dome Retaining Nut
Snap ring
Dome Assembly
Lock Ring
Dome Seal
Dome Seal Washer
Dome Seal Nut
Lockwire

e. ____1) Installation

____2) Exploded-view

____3) Detail

____4) Sectional

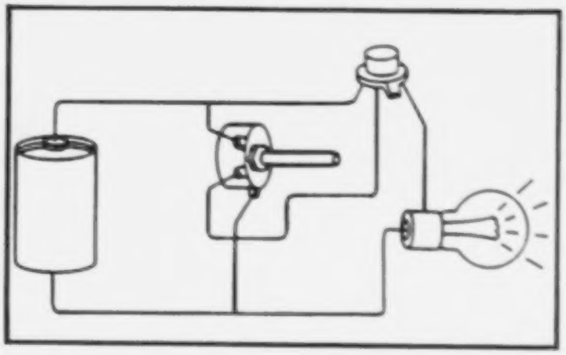

LD-Idle Position
Takeoff Position
Reverse Position
Rear Clevis End
Lock Nut
Clamping Bolt
90°+1
Cam Follower
Lever
(Installation
Dependent
On Cam Profile)
Fuel Control Unit
Actuating Lever
To Cockpit
Propeller
Governor
Unit
Propeller Speed
Select Lever
Counterweight
Propeller Typical
(In Feathered Position)
Ring Rod End
Servo Piston
Feather Return
Springs
Spring
Retainer Cup
Low Pitch and Reverse
High Pitch and Feather
Low Stop Rod
Spring
Reverse
Return
Propeller
Slip Ring
Propeller
Governor
Unit
Low Pitch
Stop
Propeller Governor
Air Pressure Tube (PV)
Beta
Control Cam
Fuel Control Unit
Reversing Lever
Push-Pull Control
Wire Rope
To Cockpit
Power
Control
Lever
Input
Lever
FCU Control
Rod
Centre Fireseal
Mount Ring
Cam
Follower
Pin
FCU Arm
Extension
Starting
Control Rod
Fuel Control
Arm
Fuel
Control Unit
To Cockpit Starting
Control Lever

f. ____1) Block diagram

____2) Logic flowchart

____3) Schematic diagram

____4) Pictorial electrical diagram



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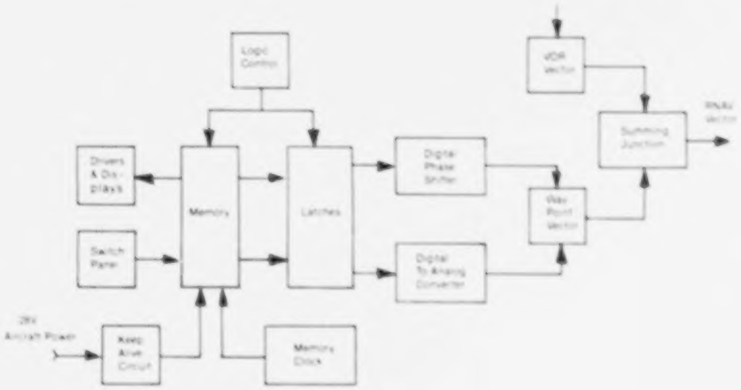
g. ____1) Logic flowchart ____3) Schematic diagram

____2) Pictorial electrical diagram ____4) Block diagram


Logic Control
VOR Vector
RNAV Vector
Summing Junction
Drivers & Displays
Memory
Latches
Digital Phase Shifter
Way Point Vector
Switch Panel
Digital To Analog Converter
28V Aircraft Power
Keep Alive Circuit
Memory Clock

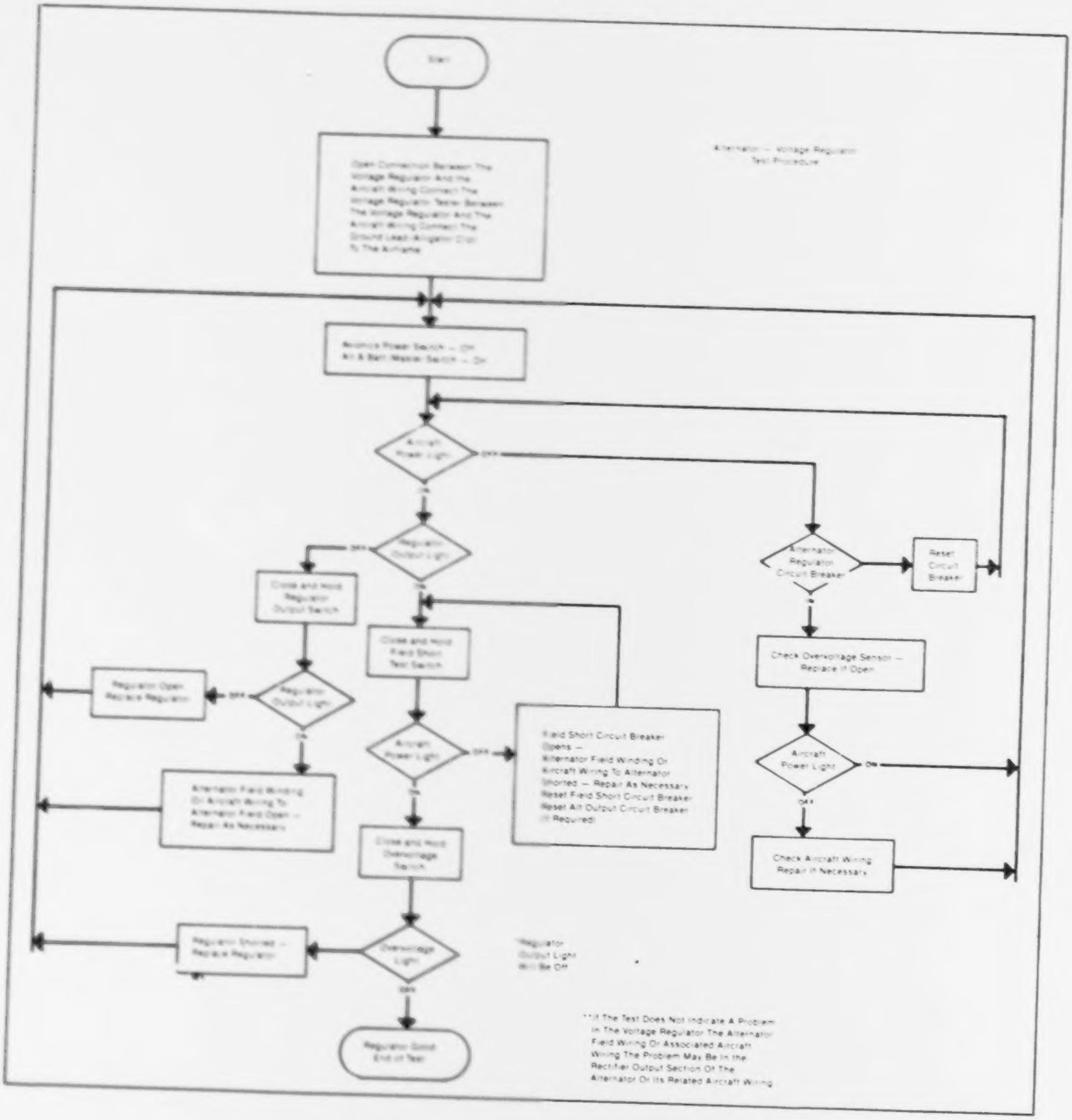
THEORY TEST

h. ____1) Block diagram

____2) Logic flowchart

____3) Schematic diagram

____4) Electrical wiring diagram


Start
Open Connection Between The Voltage Regulator And the Aircraft Wiring Connect The Voltage Regulator Tester Between The Voltage Regulator And The Aircraft Wiring Connect The Ground Lead Alligator Clip To The Airframe
Alternator — Voltage Regulator Test Procedure
Avionics Power Switch — Off
Alt & Batt Master Switch — On
Aircraft Power Light
OFF
ON
Regulator Output Light
OFF
ON
Close and Hold Regulator Output Switch
Regulator Output Light
OFF
ON
Regulator Open Replace Regulator
Alternator Field Winding Or Aircraft Wiring To Alternator Field Open — Repair As Necessary
Close and Hold Field Short Test Switch
Aircraft Power Light
OFF
ON
Field Short Circuit Breaker Opens — Alternator Field Winding Or Aircraft Wiring To Alternator Shorted — Repair As Necessary Reset Field Short Circuit Breaker Reset Alt Output Circuit Breaker (If Required)
Close and Hold Overvoltage Switch
Overvoltage Light
OFF
Regulator Shorted — Replace Regulator
*Regulator Output Light Will Be Off
Regulator Good End of Test
Alternator Regulator Circuit Breaker
Reset Circuit Breaker
Check Overvoltage Sensor — Replace If Open
Aircraft Power Light
ON
OFF
Check Aircraft Wiring Repair If Necessary
**If The Test Does Not Indicate A Problem In The Voltage Regulator The Alternator Field Wiring Or Associated Aircraft Wiring The Problem May Be In the Rectifier Output Section Of The Alternator Or Its Related Aircraft Wiring

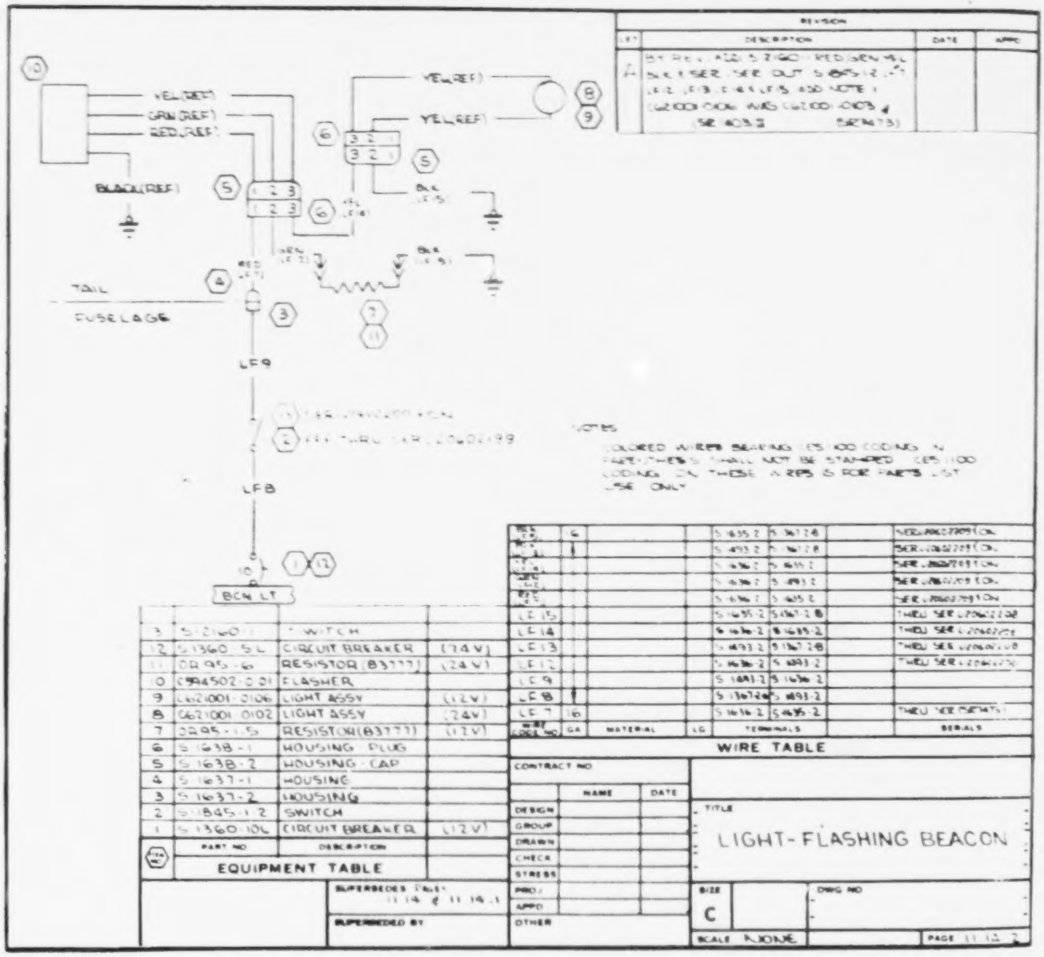
THEORY TEST

i. ____1) Schematic diagram

____2) Electrical wiring diagram

____3) Pictorial electrical diagram

____4) Block diagram


10
YEL(REF)
GRN(REF)
RED(REF)
BLACK(REF)
5
1 2 3
6
YEL
LF14
3 2 1
YEL(REF)
8
9
BLK
LF15
GRN
LF12
BLK
LF13
RED
LF7
4
TAIL
FUSELAGE
3
7
11
LF9
2
LF8
1
12
BCN LT
REVISION
LTR
DESCRIPTION
DATE
APPD
A
NOTES
COLORED WIRES BEARING LES 1100 CODING IN PARENTHESIS SHALL NOT BE STAMPED. LES 1100 CODING ON THESE WIRES IS FOR PARTS LIST USE ONLY
LF15
LF14
LF13
LF12
LF9
LF8
LF7
16
WIRE CODE NO
GA
MATERIAL
LG
TERMINALS
SERIALS
WIRE TABLE
CONTRACT NO
NAME
DATE
DESIGN
GROUP
DRAWN
CHECK
STRESS
PROJ
APPD
OTHER
TITLE
LIGHT-FLASHING BEACON
SIZE
C
DWG NO
SCALE NONE
PAGE
SUPERSEDES PAGES 11.14 & 11.14.1
SUPERSEDED BY

ITEM NO	PART NO	DESCRIPTION	
13	S-2160-1	SWITCH	
12	S-1360-5L	CIRCUIT BREAKER	(24V)
11	OR95-6	RESISTOR (83777)	(24V)
10	C594502-0201	FLASHER	
9	C621001-0106	LIGHT ASSY	(12V)
8	C621001-0102	LIGHT ASSY	(24V)
7	OR95-1.5	RESISTOR (83777)	(12V)
6	S-1638-1	HOUSING PLUG	
5	S-1638-2	HOUSING CAP	
4	S-1637-1	HOUSING	
3	S-1637-2	HOUSING	
2	S-1845-1-2	SWITCH	
1	S-1360-10L	CIRCUIT BREAKER	(12V)

EQUIPMENT TABLE

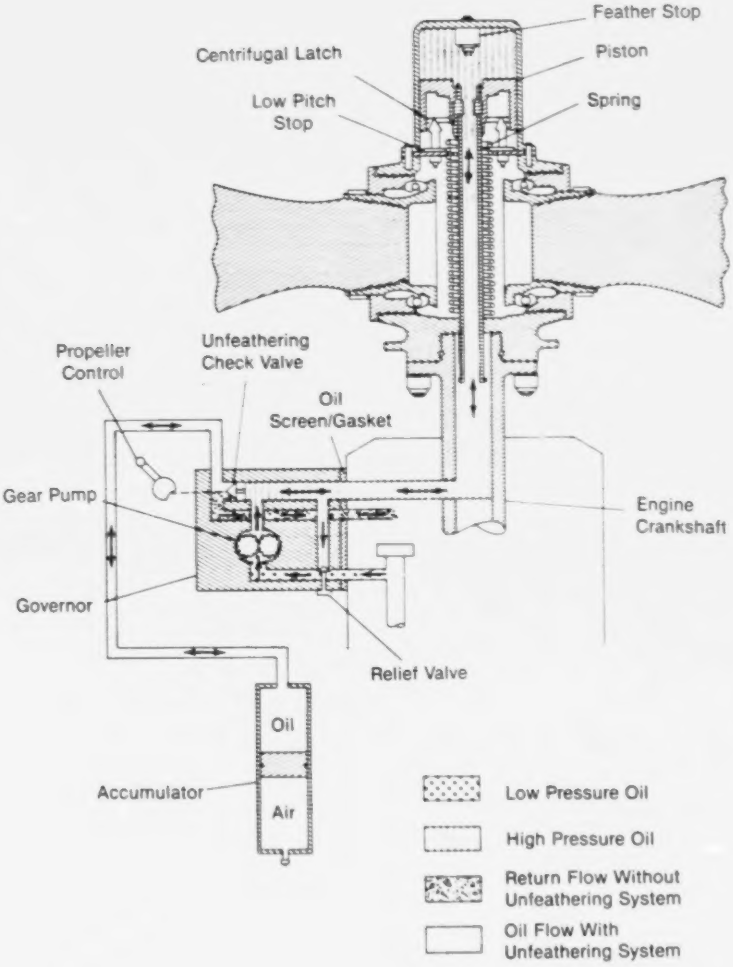
THEORY TEST

j. ____1) Schematic diagram

____2) Pictorial electrical diagram

____3) Logic flowchart

____4) Block diagram

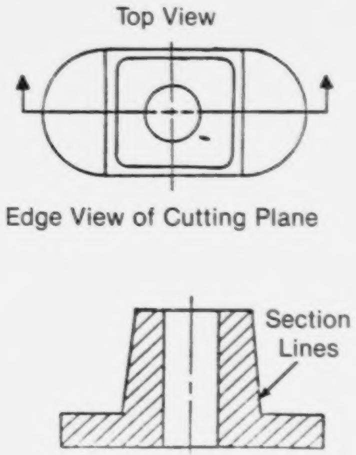

Feather Stop
Centrifugal Latch
Piston
Low Pitch Stop
Spring
Propeller Control
Unfeathering Check Valve
Oil Screen/Gasket
Gear Pump
Engine Crankshaft
Governor
Relief Valve
Oil
Accumulator
Air
▨ Low Pressure Oil
☐ High Pressure Oil
▨ Return Flow Without Unfeathering System
☐ Oil Flow With Unfeathering System

THEORY TEST

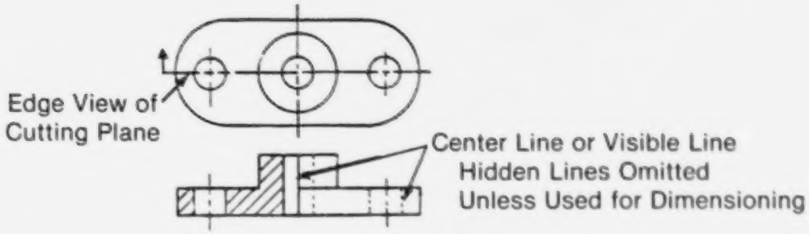
(NOTE: Test question 3 is a workbook supplement. It is an important part of this test. If it has not been completed, check with your instructor.)

3. Use orthographic exercises to construct missing views and lines.

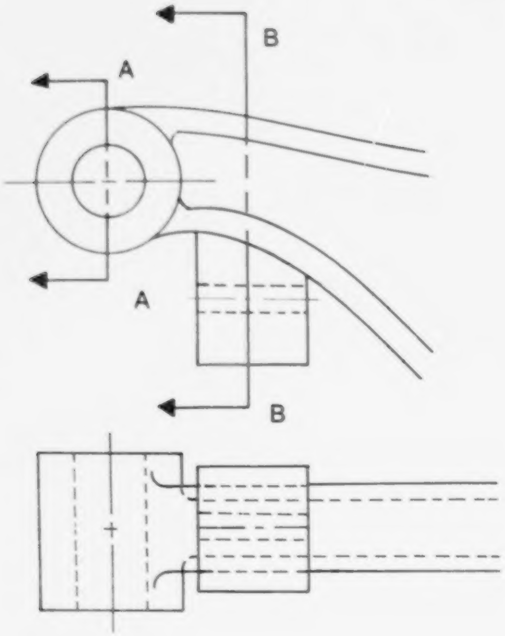
4. Identify the following types of sectional views. Write the correct names in the blanks below the illustrations.

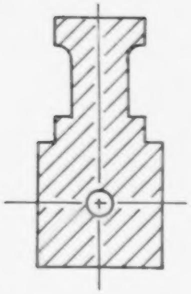

Top View
Edge View of Cutting Plane
Section
Lines

a. ____________________________


Edge View of
Cutting Plane
Center Line or Visible Line
Hidden Lines Omitted
Unless Used for Dimensioning

b. ____________________________





Section BB

c. ______________________________

5. Make sketches of the following items, using appropriate sketching techniques.

   a. Sketch three lines as follows:

      3" long, 2" long, and 1" long

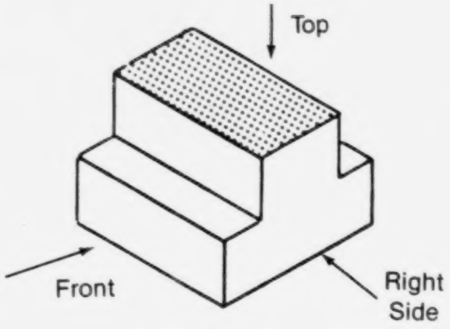
b. Sketch a circle approximately 2" in diameter.

c. Sketch a 3" square with a 1" diameter circle in the exact center.

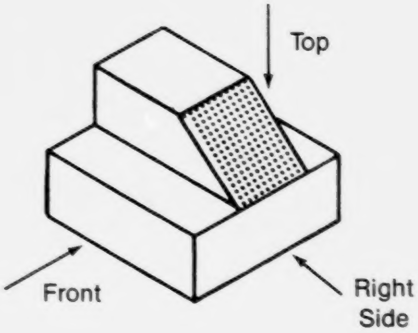
d. Fill in each corner with approximate radius of 1/2".

6. In the spaces make three-view sketches of front, top, and right-side isometric views.

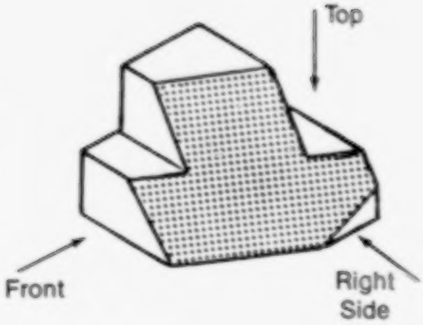
a.


Top
Front
Right
Side

b.


Top
Front
Right
Side

c.


Top
Front
Right
Side

THEORY TEST

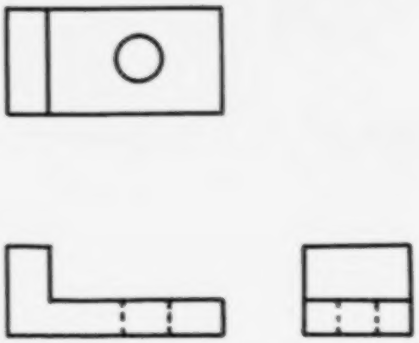
7. Match types of pictorial views to their correct descriptions. Write the correct names in the blanks.

____a. Vanishing points 1. Oblique

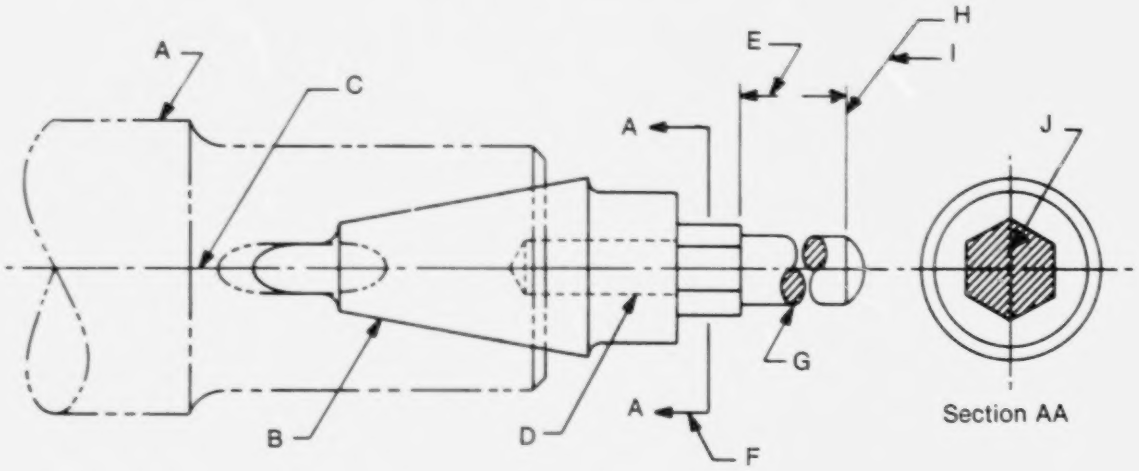
____b. Axis lines located 120 degrees apart 2. Isometric

____c. Front plane is shown in orthographic with right side and top angled to right or left side 3. Perspective

8. Make an isometric sketch of the three-view drawing pictured below.



9. Identify the types of lines commonly found on blueprints. Write the correct name of the line in the corresponding blank.



a. ____________________ f. ____________________

b. ____________________ g. ____________________

c. ____________________ h. ____________________

d. ____________________ i. ____________________

e. ____________________ j. ____________________

10. Interpret dimensions and notes on an aircraft blueprint. Use the blueprint on the following page answer the following questions.

a. What type of material is the part made from?

____

b. What is the degree of offset of the lower arm of the part?

____

c. What is the radius of the rounded ends of the part?

____

d. How are the smaller pieces attached to main body of the part?

____

THEORY TEST

e. Name the four views given of the part.

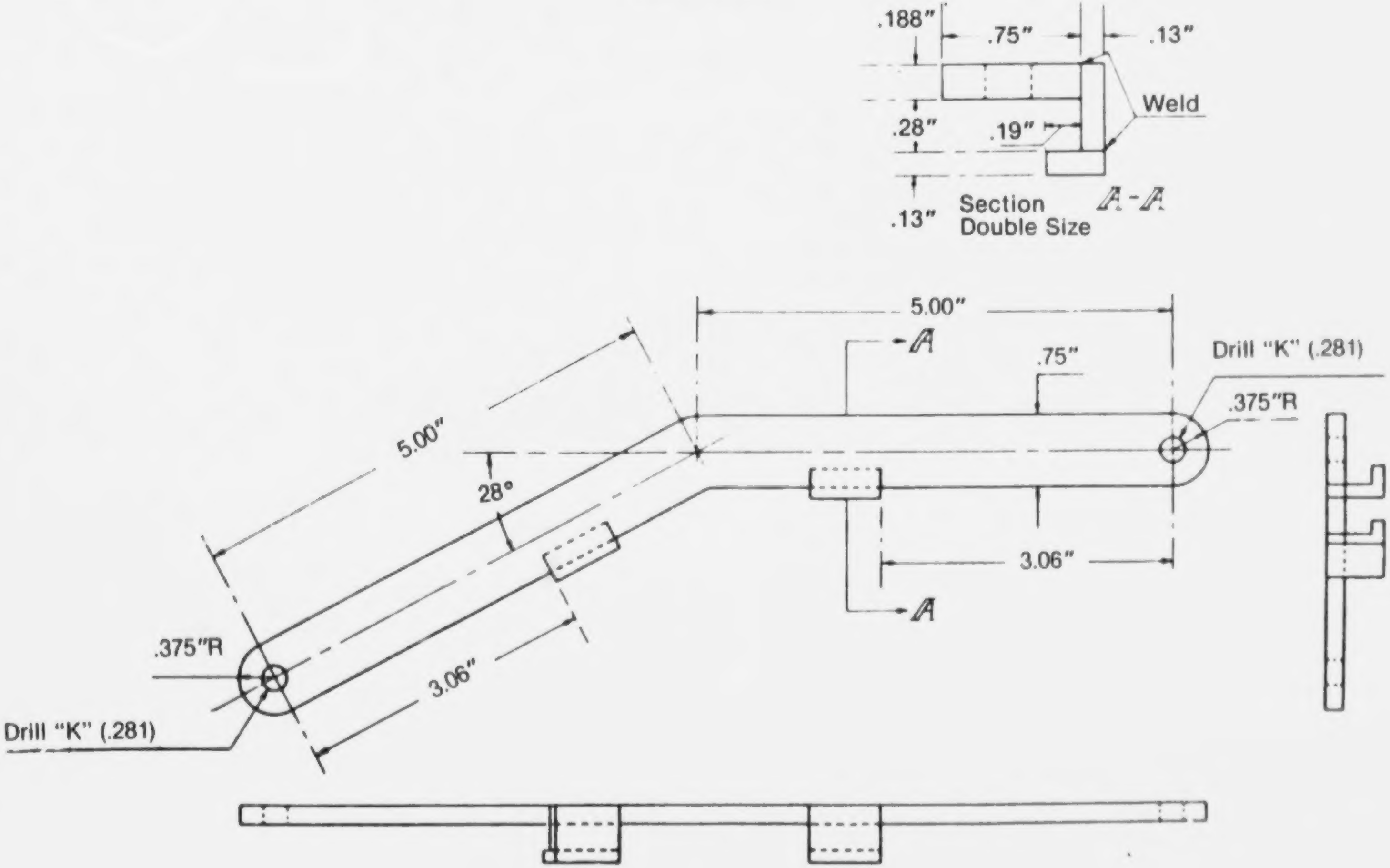
1) ____________________

2) ____________________

3) ____________________

4) ____________________

THEORY TEST


.188"
.75"
.13"
Weld
.28"
.19"
.13"
Section
Double Size
A-A
5.00"
A
.75"
Drill "K" (.281)
.375"R
5.00"
28°
3.06"
A
.375"R
3.06"
Drill "K" (.281)

Material — Steel

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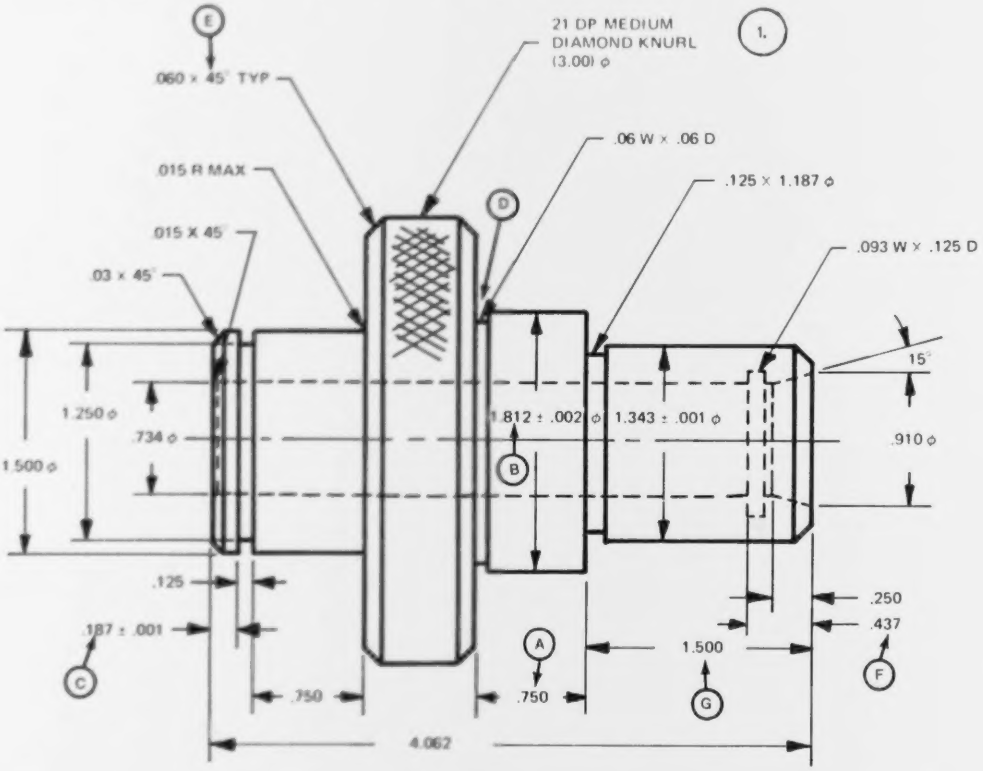
11. Using the drawing below, determine tolerancing for dimensions on aircraft drawings. Write the correct answers in the blanks.


E
.060 × 45° TYP
21 DP MEDIUM
DIAMOND KNURL
(3.00) ⌀
1.
.015 R MAX
.06 W × .06 D
.125 × 1.187 ⌀
D
.015 X 45°
.093 W × .125 D
.03 × 45°
15°
1.250 ⌀
.734 ⌀
1.500 ⌀
1.812 ± .002 ⌀
1.343 ± .001 ⌀
.910 ⌀
B
.125
.187 ± .001
C
.250
.437
A
1.500
F
.750
.750
G
4.062

NO	CORRECTIONS	DATE	APPD	TOLERANCE UNLESS OTHERWISE SPECIFIED	THIRD ANGLE PROJECTION	DWN. BY	SIGN.	DATE	PART NAME
1	21 DP WAS 14 DP	11/11	RoA	.00 = ± .010 .000 = ± .005 ANGLES ± 0°30'		DWN. BY	TBJ	6 30	SHAFT
						CHK. BY	RAK	7 2	PART NO. 50009
					SCALE FULL	FINISH 125√		MATERIAL 1117 STL	QUANTITY 750

a. What will the dimension limits be at letter "A"? ________________

b. What are the tolerance for the dimension at letter "E"? __________

c. What are the dimension limits at letter "C"? ____________________

d. What are the tolerance and limits for the groove's width and depth at letter "D"? ____

e. What is the tolerance given for the angle at letter "E"? __________

f. What are the dimensions at letter "F"? _________________________

g. What are the dimensions limits at letter "G"? __________________

12. Name five types of information found in the title block of an aircraft drawing.

a. ____

b. ____

c. ____

d. ____

e. ____

13. Describe the use of fuselage station numbers, water lines, buttock lines, and wing station numbers. Write the correct answers in the blanks.

a. Wing station numbers--____

____

____

b. Fuselage station numbers--____________________________________

____

____

c. Water lines--____

____

____

d. Buttock lines--____

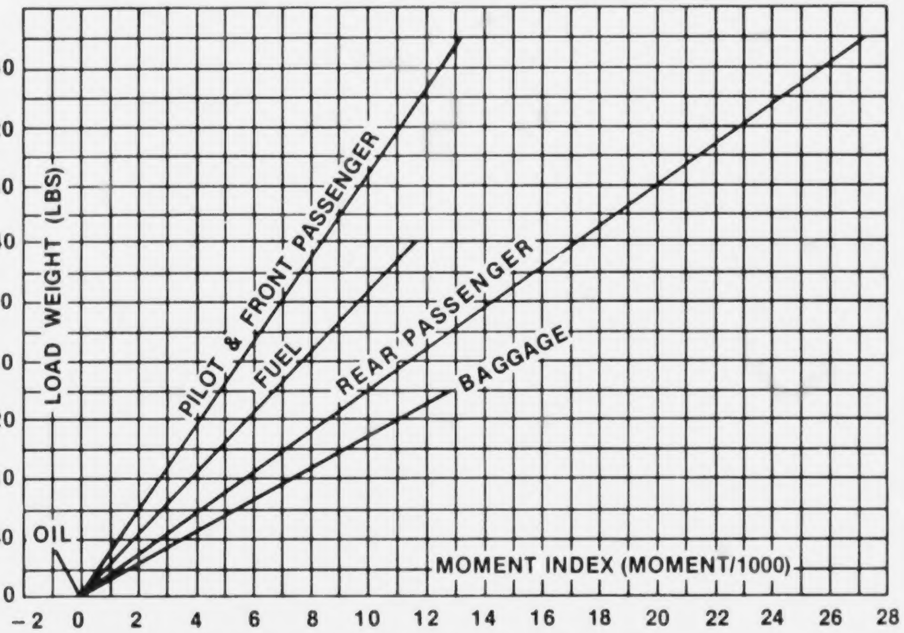
____

____

14. Interpret the information in the following graphs. Write the correct answer in the blank.

    a. Moment index for a pilot and front passanger with a combined weight of 340.

    ____



AIRPLANE EMPTY WEIGHT = 1340 POUNDS
EMPTY WEIGHT CENTER OF GRAVITY = +38.5
MAXIMUM TAKEOFF WEIGHT = 2400 POUNDS

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THEORY TEST

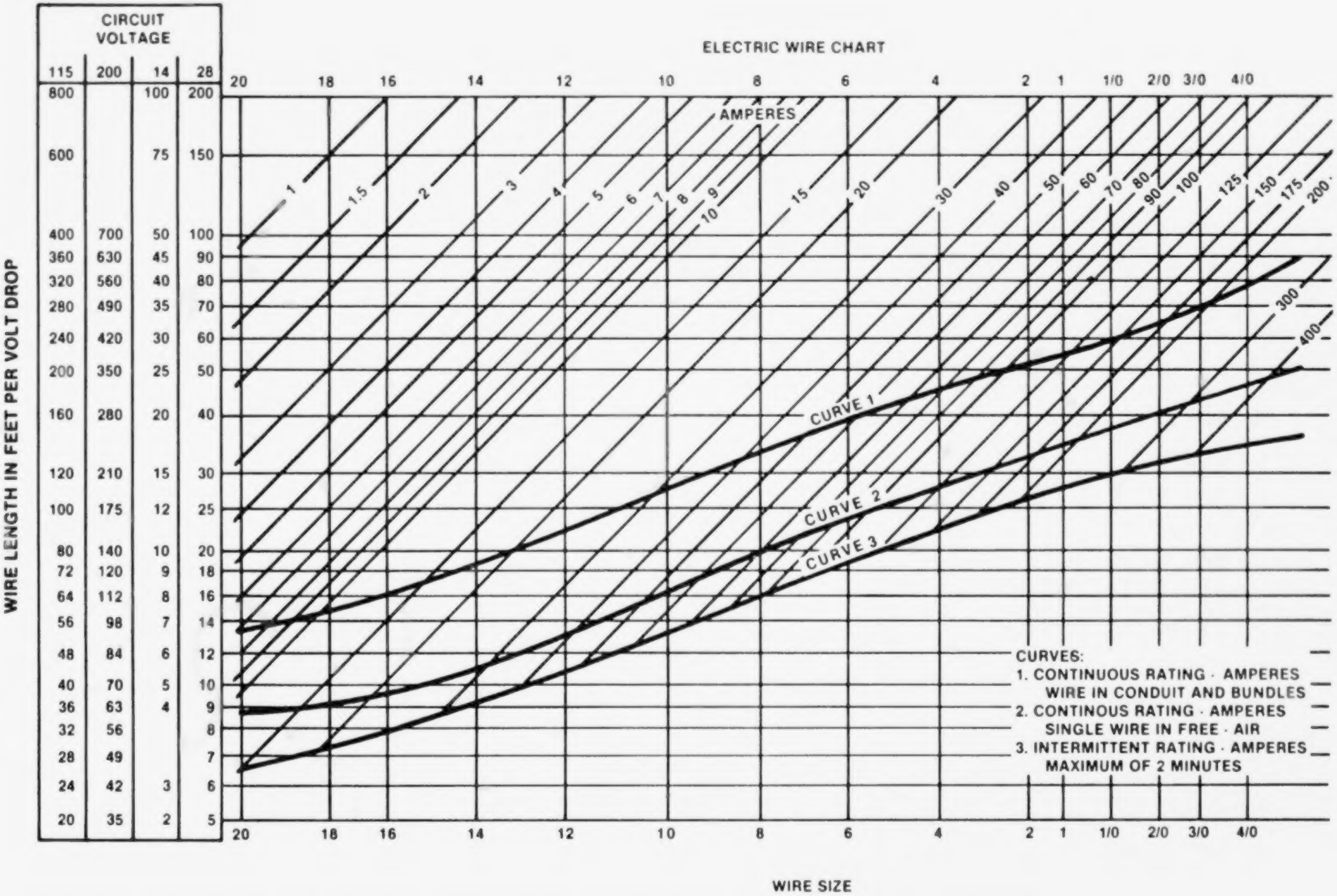
(NOTE: Use the graph on the next page to answer the following questions.)

b. What size wire would be used to carry a 100 amp current continuous for 90 feet in a conduit on a 28 volt system? ____________________

c. What size wire would be used to carry a 20 amp current intermittently for 4 feet in a 14 volt system? ____________________________________

d. What is the most current that could be carried continuous in a bundle by a 2 gauge wire for 200 feet in a 114 volt system? ________________

G102C-219



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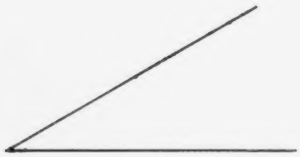
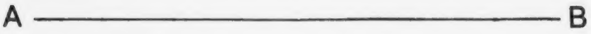
15. Perform the following basic geometric exercises.

   a. Bisect an angle.



   b. Divide a line into 5 equal parts.



16. Interpret the aircraft drawing shown on the next page to answer the following questions.

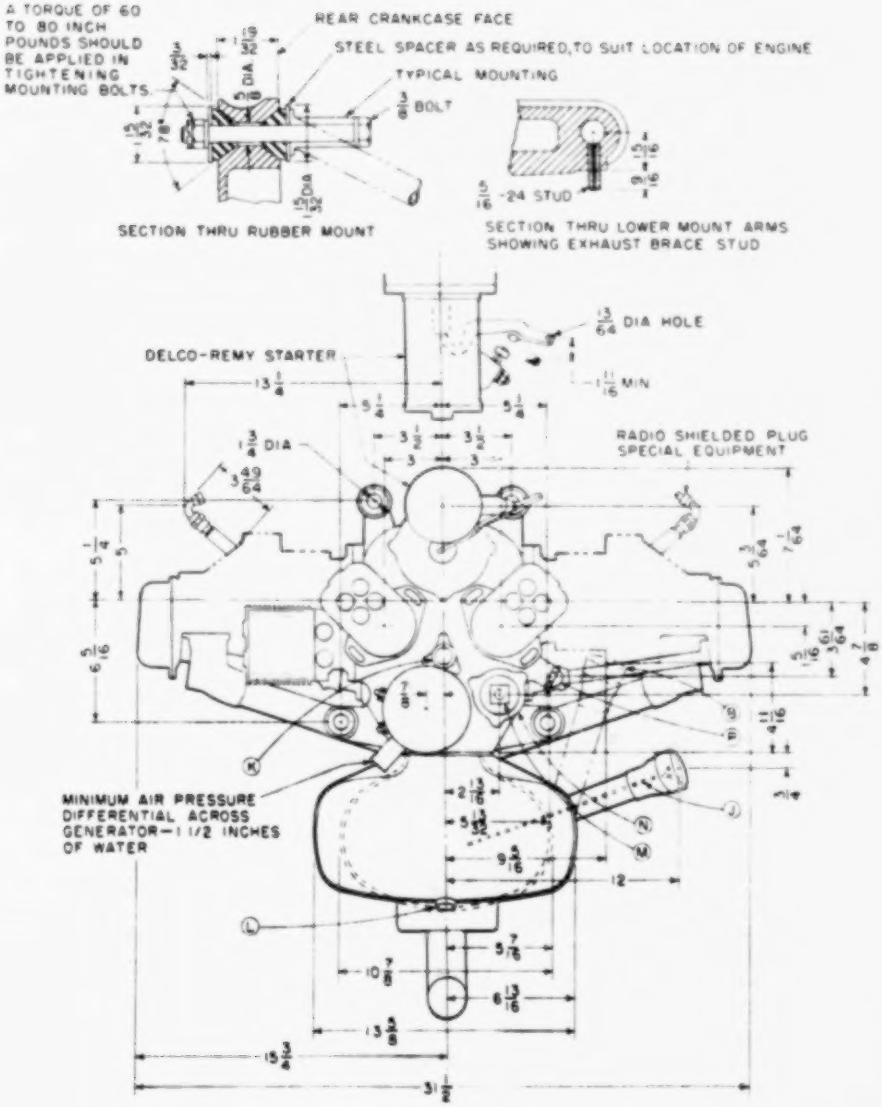
    a. What type of starter is used on the assembly? ____________________

    b. What is the total width (left or right) of the engine? ____________

    c. What should be the torque in pounds of the mounting bolts shown in the view "section through rubber mount"? ____________________

    d. What is the width of the rear crankcase face in the section through the rubber mount? ____________________

THEORY TEST


A TORQUE OF 60 TO 80 INCH POUNDS SHOULD BE APPLIED IN TIGHTENING MOUNTING BOLTS.
REAR CRANKCASE FACE
STEEL SPACER AS REQUIRED, TO SUIT LOCATION OF ENGINE
TYPICAL MOUNTING
3/8 BOLT
3/32
1 19/32
5/8 DIA
1 15/32
78°
1 15/32 DIA
SECTION THRU RUBBER MOUNT
5/16 -24 STUD
1 5/16
9/16
SECTION THRU LOWER MOUNT ARMS SHOWING EXHAUST BRACE STUD
13/64 DIA HOLE
1 11/16 MIN
DELCO-REMY STARTER
13 1/4
5 1/4
5 1/4
3 1/2
3 1/2
3
3
1 3/4 DIA
3 49/64
RADIO SHIELDED PLUG SPECIAL EQUIPMENT
5 1/4
5
6 5/16
5 3/64
7 1/64
5/16
3 61/64
4 7/8
4 11/16
3/4
7/8
K
J
N
M
L
MINIMUM AIR PRESSURE DIFFERENTIAL ACROSS GENERATOR—1 1/2 INCHES OF WATER
2 13/16
5 13/32
9 5/16
12
5 7/16
10 7/8
6 13/16
13 5/8
15 3/4
31 1/2

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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INTERPRET BLUEPRINTS AND DRAWINGS AND DRAW SKETCHES
G102-C

ANSWERS TO THEORY TEST

1. a. 2
   b. 4
   c. 3
   d. 5
   e. 1
   f. 7
   g. 6
   h. 8
   i. 9
   j. 11
   k. 10
   l. 16
   m. 15
   n. 12
   o. 14
   p. 13
   q. 18
   r. 17
   s. 21
   t. 22
   u. 20
   v. 25
   w. 19
   x. 23
   y. 24
   z. 27
   aa. 29
   bb. 28
   cc. 26
   dd. 34
   ee. 31
   ff. 30
   gg. 32
   hh. 33

2. a. 4
   b. 2
   c. 3
   d. 3
   e. 1
   f. 4
   g. 4
   h. 2
   i. 2
   j. 1

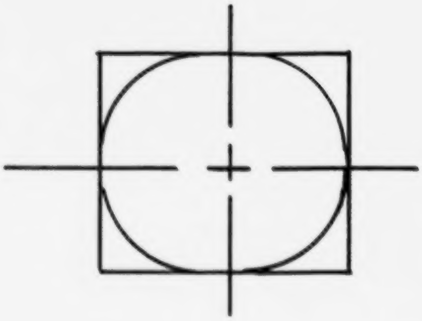
3. Evaluated to the satisfaction of the instructor

4. a. Full
   b. Half
   c. Removed

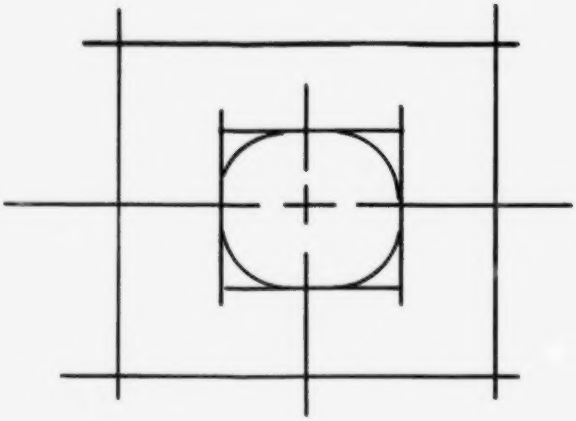
ANSWERS TO THEORY TEST

5. a.

b.

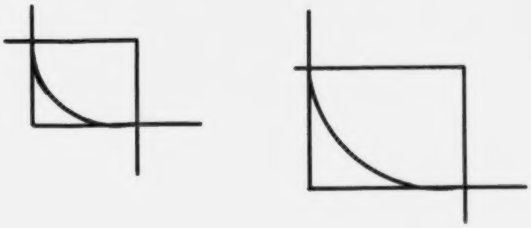


c.

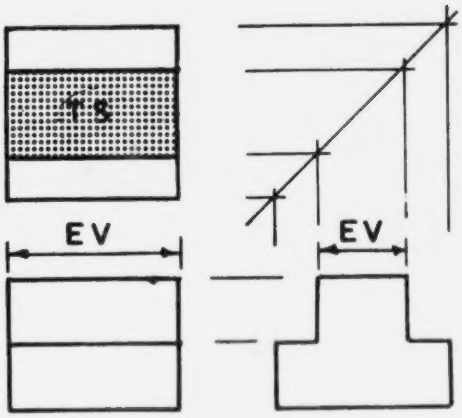


ANSWERS TO THEORY TEST

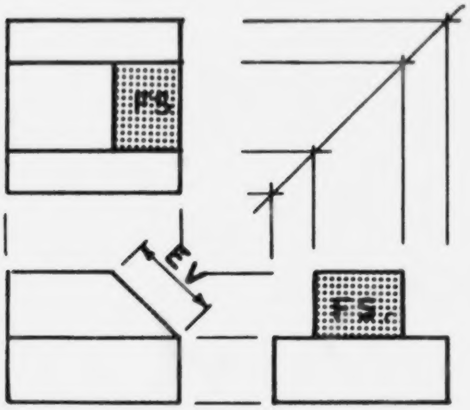
d.



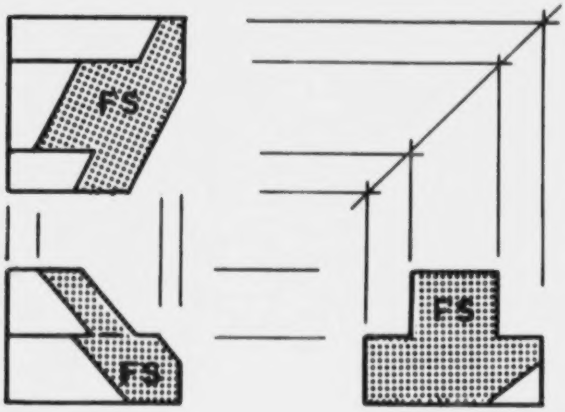
6. a.



b.

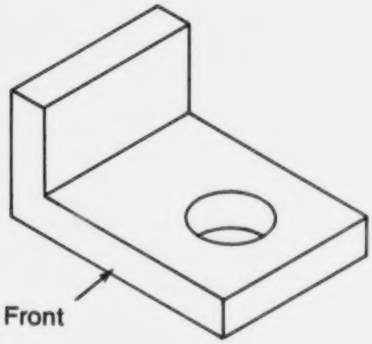


c.



7. a. 3
   b. 2
   c. 1

8.



9. a. Phantom line
   b. Visible line
   c. Center line
   d. Hidden line
   e. Dimension line
   f. Cutting-plane line
   g. Break line
   h. Extension line
   i. Leader line
   j. Section lines

ANSWERS TO THEORY TEST

10. a. Steel
    b. 28
    c. .375 R
    d. Welded
    e. Top, front, right side, section A-A

11. a. 0.74-0.76
    b. ± 0.002
    c. 0.186-0.188
    d. ±0.010/0.05-0.07
    e. ±0°/30 minutes
    f. 0.42-0.44
    g. 1.495-1.505

12. Answer should include any five of the following

    a. Title
    b. Size
    c. Drawing number
    d. Scale
    e. Page
    f. Responsibility
    g. Standards
    h. Bill of materials
    i. Application

13. a. Measured in standard or metric from the center line of the fuselage outward along the wing

    b. Measured in standard or metric from a datum called station zero, fore and aft along the fuselage

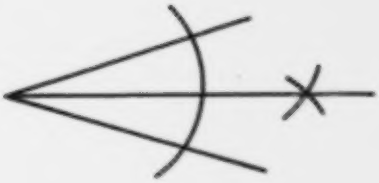
    c. Vertical measurements in inches from a datum called water line zero

    d. Distances in standard or metric right or left of the center line of the fuselage

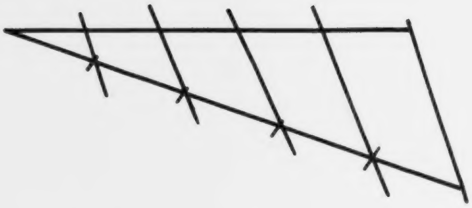
14. a. 12
    b. 2/0 gage wire
    c. 16 gage wire
    d. 90 amps

ANSWERS TO THEORY TEST

15. a.



b.



16. a. Delco Remy
    b. 31-1/2"
    c. 60 to 80 inch-pounds
    d. 1-19/32"

MODULE OF INSTRUCTION
FOR
AVIATION MAINTENANCE TECHNOLOGY

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

GENERAL

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IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES

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G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
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INTRODUCTION

As aircraft have evolved from simple wooden structures to structures made of highly complex composite materials, the inspection techniques and basic material processes have also evolved. As an aviation maintenance technician you will be responsible for identifying structural materials and performing the material processes appropriate to a particular structure.

MODULE OBJECTIVE

After completion of this module, you will be able to perform basic heat treating, foam core/glass fiber lay-up and liquid-penetrant inspection. You will also be able to perform magnetic particle inspection and visual inspections on welded assemblies. You will demonstrate this knowledge by completing the procedures outlined in the workbook assignments and project guides. You will further demonstrate this knowledge by scoring a minimum of 85 percent on the module theory test and by meeting airworthiness standards on the module practical tests.

GENERAL

G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE

IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES

G102-D

SPECIFIC OBJECTIVES

After completion of this module, you will be able to

1.	Match terms related to aircraft structural materials to their correct definitions. (1)	EA-ITP-G Technical Supplement #1	6:I:1-3
2.	State general facts related to ferrous and nonferrous metals. (1)	EA-ITP-G AC 65-9A	6:I:3-11 194-197
3.	State facts related to aluminum alloys. (1)	EA-ITP-G AC 43.13-1A AC 65-9A	6:I:3-4 129-131 197,200-201
4.	Distinguish between heat-treatable and nonheat-treatable aluminum alloys by referring to their identification markings. (1)	EA-ITP-G AC 43.13-1A AC 65-9A	6:I:3-4 129-131 198-200
5.	State facts related to thermal treatments of aluminum alloys. (1)	EA-ITP-G AC 65-9A	6:I:4-6 212-216
6.	Match temper designations to treatment processes for aluminum alloys. (1)	EA-ITP-G AC 43.13-1A AC 65-9A EA-ITP-GW	6:I:4-6 129-131 200 6:I:1-3
7.	Select statements related to magnesium and magnesium alloys. (1)	EA-ITP-G AC 65-9A	6:I:6-7 212-217
8.	State facts related to titanium and titanium alloys. (1)	EA-ITP-G AC 65-9A	6:I:7 201-202
9.	State facts related to nickel and nickel alloys. (1)	EA-ITP-G AC 65-9A	6:I:7 203-204
10.	State facts related to copper and copper alloys. (1)	EA-ITP-G AC 65-9A EA-ITP-GW	6:I:7-8 202-203 6:I:3
11.	Match eleven alloying agents found in steel to their effects on steel alloys. (1)	EA-ITP-G	6:I:9-10

SPECIFIC OBJECTIVES

12. Select statements related to alloying agents, carbon steels, alloy steels, and the SAE classification system used for steel. (1)	EA-ITP-G AC 65-9A	6:I:9-11 195-197
13. Select statements related to treatment processes for steel. (1)	EA-ITP-G AC 65-9A Workbook Supplement #1	6:I:11-14 208-212
14. State facts related to the principles of heat treatment of metals. (1)	AC 65-9A	205-218
15. Select statements related to commonly used systems for measuring the hardness of steel. (1)	EA-ITP-G AC 65-9A EA-ITP-GW	6:I:15-17 208-221 6:I:4-6
16. Perform basic heat-treating. (3)	Project Guide #1	
17. Match the three types of wood used in aircraft construction to their correct descriptions. (2)	EA-ITP-G	6:I:17-18
18. Match wood species to their correct descriptions. (1)	EA-ITP-G	6:I:18-19
19. State facts related to wood construction in aircraft. (1)	EA-ITP-G EA-ITP-GW	6:I:19-20 6:I:6-7
20. Name the two major classifications of plastic resins used in aircraft construction. (1)	EA-ITP-G	6:I:20-22
21. Select statements related to aircraft plastics. (1)	EA-ITP-G EA-ITP-GW	6:I:20-24 6:I:7-8
22. Perform a foam core/glass fiber lay-up or simple fiberglass repair. (3)	Project Guide #2	
23. Match terms related to nondestructive testing to their correct definitions. (1)	Technical Supplement #2	
24. Match inspection methods to their advantages and disadvantages. (1)	Technical Supplement #3 Workbook Supplement #2	
25. State facts related to visual inspection. (1)	EA-ITP-G	6:III:48-49

SPECIFIC OBJECTIVES

26. List the steps in performing a liquid-penetrant inspection. (1)	EA-ITP-G AC 43.12-1A	6:III:49-53 138-139
27. Select statements related to dye-penetrant inspection. (1)	EA-ITP-G AC 65-9A	6:III:49-53 477-478
28. Match types of penetrants to their characteristics. (1)	EA-ITP-G EA-ITP-GW	6:III:51-53 6:III:13
29. Perform a liquid-penetrant inspection. (3)	Project Guide #3	
30. State facts related to the principles of magnetism. (1)	EA-ITP-G	6:III:53-54
31. Match terms used in magnetic particle inspection to their correct definitions. (1)	EA-ITP-G Technical Supplement #4	6:III:55
32. Select statements related to longitudinal and circular magnetization. (1)	EA-ITP-G	6:III:56-57
33. State facts related to magnetic field strengths and sources of current for magnetization. (1)	EA-ITP-G	6:III:57-60
34. Select statements related to magnetic particle inspection and demagnetization. (1)	EA-ITP-G AC 65-9A EA-ITP-GW	6:III:60-61 472-474, 477 6:III:14-15
35. Perform a magnetic particle inspection. (3)	Project Guide #4	
36. State facts related to eddy current inspection. (1)	EA-ITP-G	6:III:61-63
37. State the principle of operation of an ultrasonic inspection. (1)	EA-ITP-G	6:III:63-66
38. Select statements related to X-ray and gamma ray radiographic inspection. (1)	EA-ITP-G EA-ITP-GW	6:III:66-70 6:III:15-16
39. Select statements related to visual inspection of welds. (1)	AC 65-9A AC 43.13-1A	486-487 30

SPECIFIC OBJECTIVES

40. List the basic characteristics of a good weld. (1)	AC 65-9A	486
41. Identify types of welding defects when given pictorial drawings and sectional views. (2)	AC 65-9A	486-487
42. Perform visual inspections of welded assemblies. (3)	AC 65-9A AC 65-15A Project Guide #5	486-487 258

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IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
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INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

I. Order materials to supplement module--Books:

A. AC 43-3 Nondestructive Testing in Aircraft

B. AC 43-7 Ultrasonic Testing of Aircraft

(NOTE: These books are available from Aviation Maintenance Publishers, Inc., P.O. Box 36, 1000 College View Drive, Riverton, Wyoming 82501.)

II. Implementation Suggestions

(NOTE: Have students read all available material related to the Specific Objectives.)

(NOTE: Due to the length of this module, it is suggested that the theory test be given in two or more parts.)

Estimated Teaching Time		Theory	Lab
Objective 1	Discuss the terms and definitions related to aircraft structural materials. Have students review Technical Information Supplement #1. Use actual materials to illustrate the stress forces affecting aircraft structural materials. The examples should portray both the stress force and the opposition to this force inherent in the materials' strength.		
Objective 2	Explain the difference between ferrous and nonferrous metals. Show Transparency Masters #1-#3. Have examples of both ferrous and nonferrous metals for the class to examine.		

Estimated Teaching Time		Theory	Lab
Objective 3	Discuss aluminum alloys. Be sure to include in the discussion the history of the aluminum alloy and the purpose in creating aluminum alloys. Name the major classifications and general applications for aluminum alloys.		
Objective 4	List the most common aluminum alloys by material code and principal alloying agent(s). Show Transparency Masters #4-#5.		
Objective 5	Discuss thermal treatments used on aluminum alloys.		
Objective 6	Discuss temper designations and explain how various processes and combinations of processes are identified by code letters. Show Transparency Masters #6-#8. Have students complete EA-ITP-GW 6:I:1-3, questions 1-21. You may want to give students an oral or written quiz to review ferrous and nonferrous metals, thermal treatments for aluminum alloys, and temper designations.		
Objective 7	Discuss magnesium and magnesium alloys. Have a sample of magnesium for students to examine. Discuss where magnesium is obtained, usages, disadvantages, advantages, corrosion, special precautions, and the ASTM classification system.		
Objective 8	Discuss titanium and titanium alloys. Have a sample of titanium for students to examine. Discuss the sources for titanium and the need which brought about development of a practical refining process. Discuss its application in alloys, usages, characteristics, fabrication problems, strength, and corrosion resistance.		

Estimated Teaching Time		Theory	Lab
Objective 9	Discuss nickel and nickel alloys. Have a sample of monel and inconel for students to examine. Be sure to discuss applications, strength, corrosion resistance at elevated temperatures, and related characteristics.		
Objective 10	Discuss copper and copper alloys. Have a sample of copper and a copper alloy for students to examine. Discuss applications in alloyed and pure form, disadvantages, advantages, and other related information. Have students complete EA-ITP-GW 6:I:3, questions 22-28.		
Objective 11	Discuss the eleven alloying agents found in steel and their effect on the steel alloy. Show Transparency Master #9. Have examples of the steel alloys for students to examine.		
Objective 12	Discuss the alloying agents used in steel, carbon steels, alloy steels, and the SAE classification system used for steel.		
Objective 13	Discuss heat treatment of steel. Include the processes of annealing, normalizing, hardening, tempering, and case hardening (carburizing and nitriding.) Have students complete Workbook Supplement #1.		
Objective 14	Explain heat treatment of metal. Show Transparency Masters #10-#12. Include in your discussion the internal structure of metals, heat-treating equipment, heating, soaking, protective atmosphere, quenching, and all the specifics about each process.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 15	Discuss the commonly used systems for measuring the hardness of steel. Show Transparency Master #13. Have students complete EA-ITP-GW 6:I:4-6, questions 29-51. Demonstrate the Rockwell Hardness Tester.		
Objective 16	Discuss the procedures outlined in Project Guide #1. Demonstrate the proper operation of the furnace and review all applicable safety precautions. Have the students complete the project guide and then review the project as a class.		
Objective 17	Explain the three common types of wood used in aircraft construction. Show Transparency Masters #14-#15. Have examples of solid wood, plywood, and laminated wood for students to examine.		
Objective 18	List the various wood species used in aircraft construction and explain their applications and any unique characteristics. Discuss wood defects. Have examples of the various woods for students to examine.		
Objective 19	Explain wood construction as it relates to aircraft. Show Transparency Master #16. Have students complete EA-ITP-GW 6:I:6-7, questions 52-57. Have a wooden wing rib and other forms of wood construction available for students to examine.		
Objective 20	Name and explain the two major classifications of plastic resins used in aircraft construction. Have examples of various thermoplastic and thermosetting materials available for students to examine.		

INSTRUCTOR'S MODULE IMPLEMENTATION GUIDE

Estimated Teaching Time		Theory	Lab
Objective 21	Discuss aircraft plastics. Show Transparency Masters #17-#19. Have examples of various reinforcing materials used with plastic resins. Use Instructional Supplement #1. Show examples of laminated construction. Have students complete EA-ITP-GW 6:I:7-8, questions 58-70.		
Objective 22	Discuss Project Guide #2. Have class complete the project guide. When completed, discuss the outcome of the project in class.		
Objective 23	Discuss terms and definitions related to nondestructive testing. Use Technical Information Supplement #2.		
Objective 24	Name the types of nondestructive inspection methods and explain the advantages and disadvantages of each. Show Transparency Master #20. Use Technical Information Suppplement #3. Have students complete Workbook Supplement #2.		
Objective 25	Explain general procedures used in visual inspections. Invite an industry representative to demonstrate the use of the video borescope. Show Transparency Masters #21-#22. Demonstrate the use of a borescope to complete a visual inspection.		
Objective 26	Discuss the steps necessary to accomplish a liquid-penetrant inspection.		
Objective 27	Discuss dye-penetrant inspections. Include in your discussion the applications for dye-penetrant inspection, common mistakes made in performing the inspection, and all pertinent safety information. Use Instructional Supplement #2. Show Transparency Master #23.		
Objective 28	Discuss the characteristics of penetrants and developers. Have students complete EA-ITP-GW 6:III:13.		

Estimated Teaching Time		Theory	Lab
Objective 29	Discuss Project Guide #3. Demonstrate the liquid-penetrant inspection. Have students complete Project Guide #3. Upon completion of the project guide, conduct a class discussion related to the project and liquid-penetrant inspection in general. Administer Practical Test #1 before continuing.		
Objective 30	Discuss the principles of magnetism. Have a permanent magnet, an electromagnet, and iron filings to help illustrate these principles.		
Objective 31	Discuss the terms and definitions used in magnetic particle inspection. Use Technical Information Supplement #4.		
Objective 32	Explain longitudinal and circular magnetization. Show Transparency Masters #24-#27. Include in your discussion the different ways longitudinal and circular magnetization of a part can be established.		
Objective 33	Discuss magnetic field strengths and sources of current for magnetization.		
Objective 34	Explain how a magnetic particle inspection is accomplished and how the part is demagnetized after testing. Have students complete EA-ITP-GW 6:III:14-15, questions 9-21.		
Objective 35	Use Instructional Supplement #3. Discuss Project Guide #4. Demonstrate magnetic particle inspections. Have students complete Project Guide #4. Upon completion of the project guide, conduct a class discussion related to the project and magnetic particle inspection in general. Administer Practical Test #2 before continuing.		

Estimated Teaching Time		Theory	Lab
Objective 36	Discuss eddy current inspections. Invite an industry representative to demonstrate and discuss the use of eddy current inspections in industry. Show Transparency Masters #28-#29.		
Objective 37	Discuss ultrasonic inspections. Invite an industry representative to demonstrate and discuss the use of ultrasonic inspection in industry. Show Transparency Master #30.		
Objective 38	Use Instructional Supplement #4. Discuss the radiographic methods of inspection. Show Transparency Masters #31-#33. Have students complete EA-ITP-GW 6:III:15-16, questions 22-32. Invite an industry representative to discuss the use of radiography in industry.		
Objectives 39-41	Discuss how to distinguish between good and bad welds. Show Transparency Masters #34-#35.		
Objective 42	Discuss Project Guide #5. Have students complete Project Guide #5. Upon completion of the project guide, conduct a class discussion related to visual inspections of welds.		

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INSTRUCTIONAL SUPPLEMENT #1--Composite Basics--Choosing Materials

THE STRUCTURAL SANDWICH

The structural sandwich is simply a particular arrangement of materials in which we make the composite of a thick, low density (and usually rather weak) core material, laced on both surfaces with a thin, high-strength skin.

In order to really be a "structural sandwich," both of these components must be present, along with another very important one, which is a very strong and rigid attachment between them. This attachment is so important that sandwiches made with rubber cement or other very weak adhesives just do not qualify as a sandwich, even if the core and facings are properly chosen.

Such "soft" structures do have a place in the scheme of things, however, and some very good baggage compartment liners are made this way. If you try to calculate their deflection under load, however, the effort always gives you a wrong answer, as they do not follow the classic formulas for sandwich structures.

The reason that the sandwich form of composites has become so frequently used lies in the fact that the thin, strong facings can be made to do an outstanding job when they are both separated and supported by the core. To illustrate this, just take a piece of skin material, such as aluminum sheet, and consider its stiffness, strength and weight as having a relative value of one. Figure 1 shows how these values increase when a core material is used to make a sandwich out of the same amount of skin material.

Although the values in the example have been calculated by Hexcel for a highly efficient honeycomb core material and adhesive system, nearly the same results are obtained when one of the low-cost foam or wood materials are used to make the core. A sandwich is simply the ultimate that can be obtained in efficiency for structural members such as plates, beams and large surfaces that have to carry a load.

Figure 1 points out the importance of making the core as thick as practicable, and most sandwiches do have a core that is a lot thicker than the facings. Because this uses a large amount of material for core, it also follows that a very light core will save a lot of weight in a structure when compared to one that weighs substantially more for a unit of volume.

As a result, it is quite common to compare core materials to each other by quoting the strength at a given density. The strength most often quoted is the compressive strength, as it is the easiest to visualize and to test. The engineers who design with these materials, however, usually also look at the shear strength and the shear modulus. (The term "modulus" is a measure of how much a material will deflect under a given load. A low modulus means that deflections, or bending, will be high, and a high modulus gives smaller deflections.)

In the sandwich structures field, the happy situation is that a great many materials make very good sandwich cores. Let's look at some of them and consider their differences.

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INSTRUCTIONAL SUPPLEMENT #1

WOODS

One of the most commonly used and lowest cost cores is any of the several light woods. The most popular is balsa, but substantial use has also been made of spruce, mahogany, redwood, pine, fir and many others.

The reason for the popularity of balsa is its good strength at very low densities. When oriented in the sandwich so that the grain direction is perpendicular to the skin, its compressive strength is higher than nearly all other cores, even that of most of the high-performance-honeycombs.

It suffers from having a shear strength that is nowhere near as impressive, and from the usual wood problems of sensitivity to fungus, rot, moisture absorption, and if you listen to those who don't like wood airplanes, termites. Because the material has such wide availability and reasonable cost, it has been (and will probably continue to be) used in many commercial, industrial and marine applications.

FOAMS

The foamed plastic materials are undoubtedly the most widely used cores in homebuilt aircraft because they are both reasonable in cost and easy to work with. Each of these material families has a set of mechanical properties, physical properties, working and handling characteristics, and cost structure all its own. It is nonsense to think one of them will be just like another.

In addition to the differences from one chemical type to another, there are also major differences between the low-density and high-density members of the same family. A two-pound per cubic foot (pcf) polyurethane will turn out to be vastly different from a 20 pcf piece having exactly the same chemistry and appearance. The resistance to gasoline and solvents, of course, will be about the same since both materials are made from the same polymer.

A few of the widely used foam materials are listed in the following paragraphs, along with some of the characteristics which distinguish them.

Polystyrene Foam

This is the material used in the VanEze and Long-Eze wings and control surfaces. It was chosen because its strength properties pretty well matched the need of this structure, and because it can be hot-wire contoured without generating poisonous gases (like the urethanes do). It has the strong disadvantage of being soluble in Styreno monomer, which is a major part of polyester and vinylester resins, and it is softened badly by exposure to gasoline.

The material usually used is Styrofoam, produced as a continuous slab by the Dow Chemical Co. It is quite uniform and reliable in its properties and is usually only available in a two pcf density, although they have made four pcf in the past. Be careful not to get hold of any "bead foam" material. This is made in many factories by exposing styrene beads, or granules, to live steam while they are contained in a closed mold. The beads expand and bond to each other, but the bond may vary greatly in strength, and the material is just not suitable as a sandwich core material.

Also, the pattern of expanded beads usually leaves an interconnecting web of tiny spaces which makes the finished material permeable to most liquids

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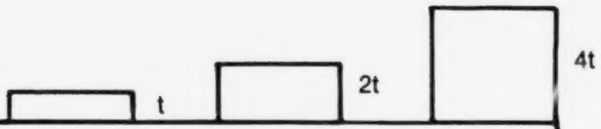
Figure 1



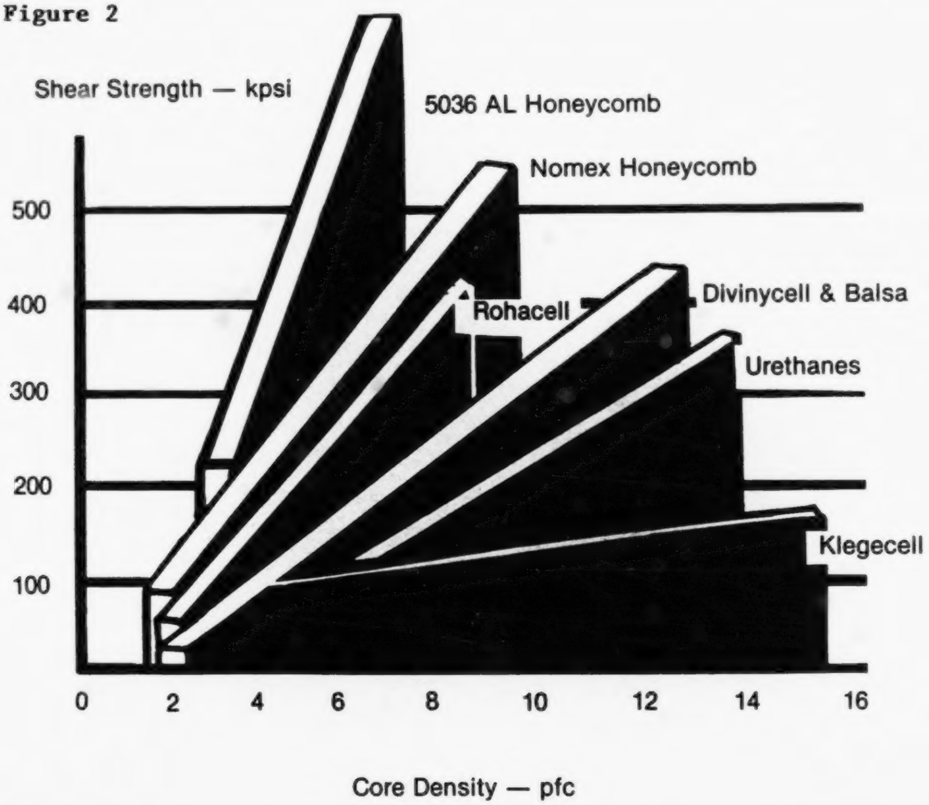
	t	2t	4t
Relative Stiffness (D)	1	7.0	37.0
Relative Strength	1	3.5	9.2
Relative Weight	1	1.03	1.06

and gases after the skin next to the mold is cut away. Definitely not the material to make your Long Eze wings out of!

Polyurethane Foam

This is a family of materials which includes both rigid and flexible materials, a great many choices of density and several different chemical versions. Care must be taken in selection of your material, as many of the sources are principally in the cushion, mattress and padding business, and

Figure 2



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do not understand the requirements of the sandwich core type of application.

Typical problems of the off-breed urethanes are excessive brittleness, variable density in a single piece, internal cracks, soft areas, and many others. Fortunately, there are some good suppliers who specialize in the sandwich core supply business and whose material rarely has such problems.

Two materials in this latter group are "Last-A-Foam" made by General Plastics, and "Clark Foam" made by Clark Foam Products. The two materials are slightly different from each other. The Last-A-Foam is light brown in color, slightly more brittle and possesses better elevated temperature properties than the Clark Foam.

Both companies make only structural foams, but Clark is an Ester-based material, while Last-A-Foam and nearly all other urethane foams are based on Polyether Densities from about 2.5 pcf to 20 pcf or higher are offered, and both suppliers make some excellent literature available to users of their materials. The Clark material will also have a slightly smaller and more uniform cell size and is tougher than nearly any of the other rigid urethane foams to be found.

A couple of words of caution regarding all of the urethane foam materials. They are usually very flammable and will produce extremely poisonous gases when burning. For this reason it is quite inadvisable to use hot-wire contouring for generating shapes from the material.

The other caution regards the practice of "foaming in place" to provide contoured shape cores. Many boat or plastic supply shops offer two-part foam-in-place urethane liquids for use in providing flotation in boats. The process seems so simple and obvious that many unwary builders (including some of the largest of the big airframe makers) have tried to make it work.

The success rate has been almost zero. The problem lies in the fact that urethane chemistry is a rather complex business, depending not just on the two components mixed in the bucket, but also on such things as humidity; barometric pressure; exact temperature of each of the components, as well as the exact temperature of both the bucket and the mold, and many other difficult-to-control factors.

This wide combination of variables make it rather unlikely that a first-time pour-in-place operation will be successful. It also highlights the fact that, in the composite structures field, much of the success of the final structure depends upon the exact outcome of a chemical reaction. This step must be carefully and reliably controlled. Where the situation makes this care and reliability difficult or unlikely, the chemical reaction should be handled by your supplier in his factory, with his resident chemist and in-house laboratory right there to make sure the chemical reaction gives the mechanical properties expected in the final product.

One other caution regarding the urethane materials should be noted. Some suppliers offer very low densities, and the mechanical property curves will often include ranges down to one or two pcf. The problem is that most urethane foam materials become somewhat unreliable at densities under four pcf, and this figure should normally be considered the minimum for good structural performance.

Polyvinyl Chloride Foams

These materials are based on the same chemical family as the familiar garbage bags, plastic pipe and plastic films in common use, but are produced

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quite differently. The manufacturing process is even more difficult than those used to produce most other foams, and the materials are consequently higher priced. Several are available to the homebuilder, all made overseas and imported.

The two most commonly used cores of these foams are Klegecell, made in France, and Divinycell, made in Sweden. A third material, Airex, made in Switzerland, is also available, but is more suited to heavier boat-type structures than to aircraft.

Both Klegecell and Divinycell are "fully cross-linked" PVC foams and make very good structural cores. Their cell size is somewhat larger than most other types of foam cores, and they are not quite so resistant to the wide range of solvents as the urethanes. Densities down to as low as 2.5 pcf are available and properties at the low end of the range are quite good. Suprisingly strengths of Klegecell foams at densities under six pcf are somewhat better than the urethanes while at the higher densities, the better urethanes have higher strength at the same density. This crossover in strength properties is not seen in any other cores.

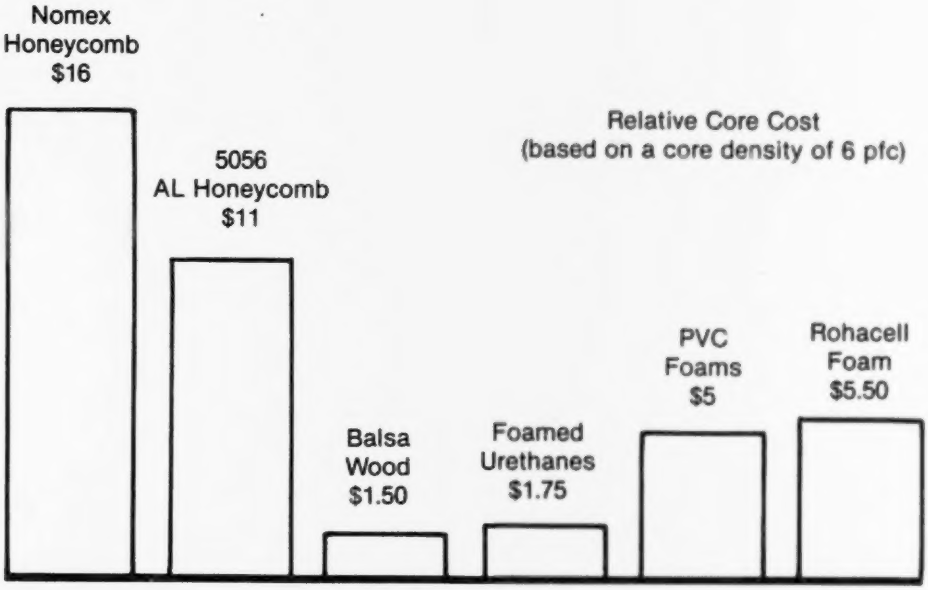
One occasional problem encountered with the PVC cores has been the infrequent occurrence of an under-cured area in the material. This shows up after layout of a sandwich as a soft area, having been attacked by the laminating resin system. Such instances, while very perplexing at the time, have been rather rare.

Polymethacrylimide Foam

Don't be put off by the impossible name of this one. It is a very high-performance material known by the trade-name of "Rohacell" and available in densities down to a featherweight 1.9 pcf. It is extremely fine in cell size and very uniform.

The mechanical properties of Rohacell are well above those of either the urethanes or the PVC foams at all densities, and it is a brilliant white

Figure 3



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color, much like Clark Foam. The materials are resistant to nearly all solvents and chemicals, and are good structures up to well above 250 degrees F. They also have the rather unusual property of expanding during cure of the facings if the cure temperature is raised to 300 or 350 degrees F. This allows a perfect fit between facings and core by simply making an approximate shape for the core and curing in a closed cavity mold.

This material has no closely equivalent competitor, but is quite generally available from Cyro Industries, a subsidiary of American Cynamid, who imports it from Germany. Cost of the material is somewhat higher than most other foams, and as a result, it tends to be used in the more weight-sensitive or critical applications. Of all the foam cores, it is the only one which is really competitive with the Nomex honeycombs in many applications in commercial aircraft.

Syntactic Foams

The word "syntactic" simply means that the foam is made by mixing micro-balloons or ceramic spheres with a resin system, and the density of the material before cure is the same as the density after cure. This is different from all other foams which are expanded during cure to make the final density of the mixed resin system just prior to blowing.

These materials may be made by the homebuilder by mixing Q-cells with the resin being used, or may be purchased already mixed with a one-part resin system. Many versions are commercially available, but they are so simple to make yourself that most homebuilders just mix them as they are needed. The usable strength of these foams will depend on the resin system employed, the particular type of micro-bubble used, and the ratio of resin to filler in your mix. Since the strongest of the range may be several times as strong as the weakest you might use, it is a good idea to stick with the exact mix specified if you are building to somebody else's plans; or, do some testing if you are striking out on your own.

A word of caution. Some of the bubbles are provided with a surface finish, just as in fibers, and this finish is only compatible with a single resin system. Be sure the material you are using is intended for use with the resin system you are mixing it with. Using the wrong resin system will result in very low strength of the final product.

HONEYCOMB CORES

There are about as many members in this family as there are in the foam family of materials, and just as you might expect, the differences between them are rather wide. One of these materials can actually be made by the homebuilder and is a pretty respectable core material.

It is formed by stacking together a great many plastic tubes, like soda straws, and pouring a solvent around them so that the solvent makes them stick together at the point of contact between the tubes. If the tubes are small in diameter, say 1/8-inch, and made of a material such as PVC, the resulting core will be comparable to some of the more expensive honeycombs. Before you start on this exercise, however, you might consider buying the material from the producer, Plascore, in Zeeland, Michigan. That's an awful lot of tubes to glue together!

All of the honeycombs suffer from the problem of open cells. That is, the core is formed from a web or film of the base material, which forms the side of nested hexagons, with the slice of material usually oriented with the axis of the cells perpendicular to the facings of the sandwich. This leaves the open hexagon exposed to the facing so that any wet resin used must be preplaced in the facing plies, as it cannot be squeegeed out after the facings are in contact with the core. Some builders have made parts by making a one-skin sandwich, curing it, and then making the second skin in a second operation, each cure being accomplished with the wet skin on the bottom side.

The far more common solution has been to employ prepregs (pre-impregnated fabric) facing plies, where the resin system has been carefully placed in the fibers in exactly the right amount and then B-staged. This results in a leathery, easily handled ply of material which can be built up into a part quite easily.

The problem is that you must then use a hot press or vacuum bag and an oven or autoclave in order to effect the final cure of the sandwich. This ends up being the standard way of making composite sandwich structures in a normal production operation in the major airframe companies, but is rather impractical for the homebuilder to consider.

The common types of honeycombs seen are fairly few. Some of them are:

Kraft Paper Honeycombs

This is the only member of the family low enough in cost to be a common candidate for the homebuilder, and there are a number of manufacturers. The problem is that all of these products, even the rather expensive resin-impregnated paper cores, are grossly affected by the presence of water vapor. At close to 100 percent humidity of the surrounding air they lose about 75 percent of their dry strength. Since this is considered as an additional problem, added to the fungus, mildew and rot problems, the decision is usually to avoid use of these materials in any aircraft structure.

Aluminum Alloy Honeycombs

Many varieties of honeycombs are made from structural foil materials of 3003, 5052, 5056 and 2024 aluminum alloys. In the airframe industry they have been the largest volume cores in use for the past 25 years and represent the most cost-effective of the honeycombs available.

In the low density ranges (two to five pcf) they are somewhat fragile, however, and have been steadily losing ground to the much more expensive Nomex cores. In non-aircraft uses, though they still are a close second to paper honeycomb, even in the architectural field.

Glass Fiber/Plastic Honeycombs

These materials have been in use for over 35 years as cores for radomes and antenna windows, but their high cost has generally restricted their usage even in commercial and military airplanes. Many variations exist, but none are really suitable for the homebuilder.

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Aramid Paper Honeycombs

This is the Nomex material, based on the Nomex paper made by the duPont Co. It is a very unusual material due to the fact that it makes a remarkably tough and damage-resistant sandwich, even when the core is at less than two pcf, and the facings are a single ply of 10-mil glass cloth.

That particular combination makes up a large part of the cabin interior structure of the typical Boeing commercial aircraft. Even in the floor panels the core density is only four to six pcf, except in the aisles of the larger planes, where densities up to nine pcf are used to resist the wheel loads imposed by food service carts. The problem of achieving a realistic skin bonding method is probably the only thing that will continue to stand in the way of more substantial usage by homebuilders.

Carbon Fiber and Kevlar Honeycombs

Made only in the laboratory, and they cost a fortune!

Stainless Steel, Titanium and Superalloy Honeycombs

In production, but average about $800 per board foot (and up).

STRENGTH COMPARISIONS OF CORE MATERIALS

Comparing the strength of various cores is a little bit dangerous, as the results not only depend on the test method, but also on what has been done to the core during fabrication of the sandwich. If the core is one that is softened by polystyrene, and a polyester or vinylester resin system is used in laying up the sandwich, the final product will be a lot weaker than the core producers' literature says it will. Nearly all of the core materials have some such "Achilles Heel" to which they may be sensitive, and the builder must be sure he fully understands all of the many relevant facts concerning the materials he plans to use before attempting to start on his structure.

Assuming this is properly researched and that these facts are understood and the problems avoided, the graph of Figure 2 shows the relative strength of some of the core materials mentioned previously. The strength can clearly be seen to increase with higher density. This is true for all cores, not just for the shear strength shown, but for values of all other strengths and for the several modulus values as well.

COST COMPARISONS OF CORE MATERIALS

The cost of the various core materials seems to be as different as their strengths, although placing any reliance on a summary of costs can be a risky business. The real cost is what you actually have to pay for the material when and where you buy it.

Naturally, if you are at Boeing and have a requirement that amounts to $5 or $10 million worth of core, the suppliers are going to really sharpen their pencils and offer some attractive pricing. If you are just Joe Homebuilder, however, your shipment is not going to justify anybody making a special production run, and you must depend on a Wicks or an Aircraft Spruce to already have the material in stock. Obviously, the price will include both their profit and their cost to buy and inventory the stuff.

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INSTRUCTIONAL SUPPLEMENT #1

Even with this large discrepancy in pricing, however, the relationship between the different cores' costs is rather stable. The graph of Figure 3 attempts to show this relationship. Note that even in the cost chart, only balsa has a cost that is not dependent upon the density of the core. In all other cores, the more material you buy (in pounds), the greater the cost will be.

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INSTRUCTIONAL SUPPLEMENT #2--Fluorescent Penetrant Inspection

1. General

A. Fluorescent penetrant inspection is a nondestructive means of inspecting materials and parts for surface discontinuities and imperfections. The fluorescent penetrant inspection procedures described in this section are based on the use of either a water-washable fluorescent penetrant or a high sensitivity fluorescent penetrant requiring the use of separate penetrant remover or emulsifier.

B. Parts that have been processed in accordance with one of the Service Process Operation Procedures (SPOP), shall be inspected and the number, nature and extent of defects found shall be tabulated. Inspectors shall be thoroughly trained specialists capable of evaluating correctly the indications and deciding whether parts are suitable for further service, require repair, or must be rejected.

C. These instructions shall not replace but shall supplement regular visual inspection procedures.

2. Description

(1) Satisfactory functioning of fluorescent penetrant processes depends on defects being open to the surface to allow penetration of the penetrant. Therefore, it is essential for the surface to be absolutely clean and all debris around and in the discontinuity must be removed. The cleaned part is then immersed in or sprayed with penetrant. Parts flood sprayed or immersed in penetrant are then drained. Excess penetrant is removed by water washing only or by the application of a separate penetrant remover or emulsifier followed by water washing. The part is then dried, generally by the application of warm dry air, followed by exposure to a dry developer. The developer draws the penetrant from the defects rendering them readily visible when viewed under ultraviolet light.

(2) Two types of penetrant removers are referred to in the SPOPs. One (ZE3) may be defined as being lipophilic in nature, the penetrant and remover being mutually soluble. The other (9PR4) is known as a hydrophilic penetrant remover. The two differ in the hydrophilic/lipophilic balance of their surface-active agent systems, which is higher in the hydrophilic type. Since the penetrant and hydrophilic type remover are mutually insoluble, the emulsification period is less critical and it is less likely that penetrant will be removed from a shallow defect. Indications of maximum brightness are also possible with a hydrophilic remover since there is no dilution of penetrant in a defect.

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3. Method

Six general procedures, SPOPs, have been evolved for detecting defects in parts incurred during service. All parts which require fluorescent penetrant inspection are listed in the Engine Overhaul Manual with the SPOP by which each part must be inspected. When necessary, exceptions to regular inspection procedures are noted. Surfaces of parts requiring particular attention are lugs, bosses, webs, splines, teeth, flanges, cutouts, shoulders, slots, welds, and brazing.

4. Equipment and Materials

A. Materials

(1) Materials may be obtained from several sources. Materials listed here have been found satisfactory and are used in the SPOPs presented in this section.

Material	Designation
Water-washable Penetrants	ARDROX 970-P8, 970-P10 ZYGLO ZL-1C, ZL-15 TRACER-TECH P-133A TURCO WP-1
High Sensitivity Penetrants (Non-Water Washable)	ARDROX 985-P2 ZYGLO ZL-22, ZL-22H, ZL-30A TRACER-TECH P-149 SHERWIN FP-22 TURCO P-41
Emulsifiers or Penetrant Removers	ARDROX 9PR4 (water base) ZYGLO ZE-3 (oil base) TRACER-TECH E-153 SHERWIN ER-82 TURCO E-41
Dry Powder Developers	ARDROX 9D3 ZYGLO ZP-4, ZP-4A TRACER-TECH D-493 SHERWIN D-90 TURCO DD-2
Cleaner	ZYGLO ZC-7
Wet Developer	ZYGLO ZP-9

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B. Equipment

(1) Equipment which is designed to fit the needs of this type of inspection may be obtained from several sources. In some circumstances locally fabricated or general purpose equipment may be used. Special equipment may also be used to provide semi-automatic or automatic handling of parts depending on volume.

(2) For immersion and flood spray penetrant application methods, mild steel tanks large enough to accept the larges parts are needed to hold the penetrants and emulsifiers. Suitable drain trays shall be located adjacent to each tank.

(3) For electrostatic spray fluorescent penetrant inspection, only an exhausted, drain-equipped booth large enough to accommodate the largest part being inspected is required. Application of the penetrant, cold water washing, drying, and dry developer application is completed within the one booth. Suitable electrostatic spray systems for applying cold water-wash fluorescent penetrant directly from a received drum are available, among others, from the following sources:

Static Spray Systems
P. O. Box 396
Norwalk, Connecticut
06856

Eclipse Equipment Co.
28 Kulick Road
Fairfield, New Jersey
07006

Brent Chemical
Products, Ltd.
Commerce Road
Brentford, Middlesex,
England

The DeVilbiss Company
300 Phillips Avenue
Toledo, Ohio

Ransburg Electro Coating Corp.
P. O. Box 88220
Indianapolis, Indiana 46208

(4) A water spray rinse and/or dip bath tank capable of delivering water at temperatures from 60°F (15°C) to as hot as 160°F (71°C) are needed depending on requirements of materials used.

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(5) A drying oven with a thermostatically controlled recirculating warm air feature or an exhausted booth is necessary for drying parts.

(6) A means for applying dry powder developer is required and usually takes the form of a so-called "dust storm cabinet".

(7) A suitable ultraviolet lamp (black light) is a Westinghouse or General Electric mercury projector lamp No. CH-4 (spot) or EH-4 (flood) using a Kopp No. 41 filter or its equivalent. A reactor-transformer must be used between the lamp and the 110 volt current source. Another suitable ultraviolet lamp is the Hanovia Model 16 obtainable from Englehard-Hanovia, Ltd., Bath Road, Slough, Bucks, England.

NOTE: It is often convenient to install large flood type ultraviolet lightening, which, although inferior to the hand type lamp, can aid inspection of large parts before local inspection with a hand lamp.

5. Maintenance of Equipment and Materials (Magnaflux System)

A. Black light lamps and filters used during fluorescent penetrant inspection must be checked every 30 days with a Weston Sight-Light Meter, Model No. 703, Type 3A, or equivalent. Use a 10 power multiplier disk to obtain proper range on meter. A visual correction filter must not be used with meter.

(1) Turn on lamp for not less than 15 minutes before measuring light intensity in order to permit vapor to stabilize.

(2) Install filter regularly used with lamp.

(3) Measure light intensity with meter held 12 inches from black light lamp.

(4) Light intensity of less than 200 foot-candles warrants replacement of lamp.

B. Materials

(1) Tank retained washable and nonwater washable penetrants and emulsifiers must be tested regularly to ensure reliable fluorescent penetrant inspection of parts. While frequency of tests will vary with use of materials, standard time intervals for testing penetrants and emulsifiers should be established.

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(2) Tests described in this section are intended to show suitability of materials under average conditions. Tests are based on comparison of new and used ZL-1C, ZL-15, ZL-22, ZL-22A, ZL-22H or ZL-30A Penetrants and ZE-3 Emulsifier. Operators are responsible for developing satisfactory substitute tests for equivalent materials.

(3) A one or two pint sample of penetrant shall be taken from a shipment of new material for comparison with used materials. Samples of new material should not be exposed to extreme temperature or direct sunlight.

6. Performance Comparison Test of New and Used Materials (Magnaflux System)

A. With aluminum test specimens, Magnaflux Corporation Part No. 14755 or equivalent, inspect each half simultaneously - one half with new materials, the other with used materials. Use each Service Process Operation Procedure and its applicable materials.

B. During washing operation, note ease with which penetrant is washed from parts and amount of fluorescent background remaining.

C. Under black light, inspect for defects. Pay particular attention to:

(1) Brilliance of indications.

(2) Extent to which very fine cracks are shown.

(3) Extent to which indications are retained in wide cracks.

(4) Amount of fluorescent background.

D. If there is little or no perceptible difference between inspection with used and new materials, penetrant and/or emulsifiers may be considered satisfactory.

E. If brilliance is low, fine cracks are not shown, or wide cracks are washed out, penetrant should be replaced.

F. If washing is difficult or fluorescent background is excessive, penetrant and/or emulsifier is below standard and must be replaced.

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7. Maintenace of Equipment (ARDROX System)

A. Due to the absence of calibration standards for ultraviolet light, measurement of the output of ultraviolet lamps in definite units is not practically possible. However, by using a photocell which is sensitive to ultraviolet radiation, in conjunction with a filter which transmits only ultraviolet light, readings in arbitrary units may be obtained. Deterioration in output of lamps with age is then readily detected by comparison.

B. Equipment needed to check output of ultraviolet lamps consists of a photocell such as a Lightmaster Photometer made by Evans Electroselenium, Ltd., Chance OX1 filter or equivalent, a stand to support the lamp, and a centimeter or inch scale.

C. Procedure

(1) Switch on a new lamp and condition for 20 minutes.

(2) Fit filter over photocell.

(3) Mount new lamp on stand at a convenient height. Adjust lateral position of photocell until maximum meter reading is obtained.

(4) Measure and record lamp to photocell distance.

(5) Read and record meter reading.

(6) In subsequent tests the lamp is relocated at the recorded distance from the photocell and the reading is recorded. Compare this reading with initial reading and calculate percentage of loss.

(7) When an appreciable loss in noted, disassemble lamp and clean filters, reflectors, and bulb in an attempt to restore output.

(8) When a loss of more than 25% is experienced, despite cleaning, discard the lamp.

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8. Control of Material (ARDROX System)

A. General

(1) Water-washable and nonwater-washable penetrants and penetrant removers must be tested regularly to ensure reliable inspection of parts. While frequency of test will vary with use of materials, standard time intervals for testing penetrants and penetrant removers should be established which do not exceed 40 working hours.

(2) Control tests recommended by the manufacturer of penetrant inspection materials shall be applied as directed. Methods of control consist of comparing samples of process materials with retained standard samples of materials used. Store retained standard samples in closed dark glass containers, away from direct sunlight, and protected against extremes of temperature.

(3) Contaminants which will affect the efficiency of penetrant inspection materials include oils and greases; water and penetrant removers; nonfluorescent dyestuffs, such as visible dye penetrants; dust and general shop debris. It is important to ensure that these do not contaminate the penetrant and therefore it is important that parts are meticulously cleaned by the applicable cleaning SPOP before inspection. Penetrants will absorb water and/or penetrant removers which will cause cloudiness and increased viscosity, leading to reduced efficiency which could ultimately cause separation, resulting in poor rinsability and high background fluorescence. Therefore, it is most important to ensure that penetrant remover and water rinsing facilities are positioned so as to avoid this type of contamination. Penetrant tanks should preferably be fitted with a lid when not in use to prevent airborne contamination, including water droplet condensation. Since nonfluorescent dyestuffs will rapdily reduce fluorescence, every effort must be made to avoid this form of contamination, especially as a result of proximity to any other dye penetrant process or from parts previously treated with dye finishes.

(4) Provided reasonable care is taken and the installation is maintained at a fixed working level, there should be little decrease in efficiency over long periods of time.

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B. Control of Tank Working Level

(1) Losses will occur by drag-out so it is important to maintain the tank working level.

(2) When tank is filled initially, determine depth of liquid and mark tank, or determine depth with a dipstick.

(3) When depth of liquid falls below 90% of original volume it should be restored by adding fresh penetrant.

C. Penetrant Performance Control Test (ARDROX System)

(1) This test is most important since it is the factor which determines whether or not an installation is working properly. Make tests on samples drawn from tank after the working level has been restored and the solution thoroughly agitated. A samples of the penetrant under test is taken from the tank. Test panels containing known flaws are then subjected to a comparison using the test sample and the retained standard sample (of new material).

(2) Test panels are aluminum alloy 4 x 2 x 3/8 inch which are divided into two facial sections of 2 x 2 inches by a groove 1/4 inch wide and about 0.015 inch deep. Thermal cracks are produced in the blocks by heating and quenching at controlled temperatures before the groove is cut. The two faces are identified by lightly etching "A" and "B", one on each.

(3) Use the following sequence of procedures to perform the test.

(a) Immediately before using test panels expose them to two cycles of 15 minutes each in trichlorethylene vapor and allow to cool.

NOTE: Test panels are treated and preserved as specified under paragraph D, Maintenace of Test Panels.

(b) The applicable fluorescent penetrant inspection SPOP is then performed using the retained sample to treat surface "A" and using the sample of penetrant under test to treat surface "B". Position test panel so draining takes place without intermixing penetrant from the two surfaces.

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(c) In the case of high sensitivity penetrant, penetrant removal is done using a freshly prepared 20% solution (20 parts remover to 80 parts water) of penetrant remover drawn from the retained standard sample.

(d) Use fresh developer drawn from the retained standard sample to dust the test panel.

(e) Examine under ultraviolet light to determine whether there are significant differences between the control, surface A, and the sample under test, surface B.

D. Maintenance of Test Panels (ARDROX System)

(1) Test panels shall be thoroughly cleaned after each use and properly stored until used again.

(2) Rinse thoroughly in running water to remove all traces of developer.

(3) Swab with acetone and allow to dry.

(4) Clean with two 15 minute cycles in trichlorethylene vapor and allow to cool after each exposure.

(5) Store test panels in a sealed jar containing a mixture of 50% toluene and 50% trichlorethylene (inhibited) so that they are totally immersed and leave them in this mixture until they are used again.

E. Control of Fluorescence Brilliance (ARDROX System)

(1) Experience has shown that no significant deterioration of fluorescence occurs in practice provided care is taken to avoid contamination. Penetrant tanks should, however, be located so they are not exposed to direct sunlight.

(2) The following procedures shall be carried out to determine whether contamination has reduced fluorescent brilliance.

(a) Saturate a piece of filter paper with the penetrant being tested and a similar piece of filter paper with the retained standard sample.

(b) Examine the two filter papers side by side under ultraviolet light. The degree of fluorescence should be comparable.

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(3) If an appreciable difference is noted, an approximation of the actual percentage of loss in fluorescence may be estimated by diluting portions of the control solution with varying amounts of kerosene and comparing the dilutions with the material under test as before.

(4) A loss of fluorescence does not mean that the penetrant solution must be discarded, provided the performance test remains satisfactory. However, if there is a steady loss of fluorescence, it means there is a contamination factor which must be investigated. If fluorescent efficiency drops below 90% discard the solution.

F. Rinsability Test Applicable to ARDROX 970-P8 and 970-P10

(1) Using two panels of identically shot-blasted aluminum alloy, approximately 3 x 6 inches, a small quantity of degreasing solvent such as acetone or trichlorethylene, some filter paper and a supply of retained standard penetrant, evaluate the thoroughness with which the water-washable penetrant can be removed.

(2) Thoroughly degrease the two panels with acetone or trichlorethylene and wipe dry with filter paper.

(3) Apply penetrant to be tested to one panel and the retained standard penetrant to the other panel by brushing or dipping. Suspend panels vertically to drain for two minutes.

(4) Rinse panels thoroughly with cold water, being extremely careful to ensure identical rinsing conditions for each panel.

(5) Dry both panels with compressed air and examine under ultraviolet light. The degree of background fluorescence from the penetrant being tested should not be substantially greater than that of the retained standard penetrant.

G. Control of Penetrant Remover ARDROX 9PR4

(1) Control of diluted ARDROX 9PR4 (18 to 22 parts 9PR4 to 78 to 82 parts water) penetrant remover is simple and only requires compensating for drag-out losses and finally replacing the material when contamination by penetrant is impairing the penetrant removing properties of the solution.

(2) Drag-out losses are mainly controlled by the operator. Position parts in such a way that all excess penetrant remover readily drains off. Rotate parts if necessary to avoid entrapping solution in crevices and recesses.

(3) Viscosity of the diluted solution is only a little greater than that of water; therefore only a short drainage time is needed after parts have been immersed in the remover.

NOTE: Adequate drainage time and proper positioning of parts will keep drag-out to a minimum since only a little remover will remain on the parts.

(4) Mark the operating level on the tank or on a dipstick. Maintain this level by periodic additions of freshly prepared solution consisting of 18 to 22% penetrant remover to 78 to 82% water.

(5) As the penetrant remover solution becomes contaminated with penetrant, measure the loss of efficiency by comparison with the retained standard sample. Materials needed consist of two identically shot-blasted aluminum panels about 3 x 6 inches, a small quantity of degreasing solvent such as acetone or trichlorethylene, some filter paper, a supply of ARDROX 985-P2 penetrant retained sample, a supply of ARDROX 9PR4 solution to be tested and a supply of retained standard sample of diluted ARDROX 9PR4.

(a) Restore tank to proper work level with diluted ARDROX 9PR4 and mix thoroughly.

(b) Withdraw sample for test.

(c) Thoroughly degrease the two panels using acetone or trichlorethylene and dry with filter paper.

(d) Apply ARDROX 985-P2 penetrant to each panel by brushing or dipping; then suspend panels vertically for 10 minutes to drain.

(e) Immerse one panel in penetrant remover under test and the other panel in retained standard penetrant remover, each for 60 seconds.

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(f) Rinse panels immediately with cold water ensuring identical rinsing conditions for each panel.

(g) Dry both panels with compressed air and examine under ultraviolet light. The degree of background fluorescence from the remover being tested should be not substantially greater than that of the retained standard sample.

(h) When this test shows an appreciable drop in efficiency discard the remover solution and refill tank with a fresh solution using 18 to 22% ARDROX 9PR4 and 78 and 82% water.

NOTE: When remover has been in use for some time it will absorb some amount of penetrant. While the tank is in use this penetrant remains finely dispersed throughout the solutions in the form of an oil-in-water emulsion. If solution is allowed to stand undisturbed for any length of time, such as two days or more, penetrant will separate as an orange scum on the surface. This scum is quickly dispersed by agitation or by resuming normal work with the tank.

H. Care of Dry Developing Powder ARDROX 9D3

(1) No special control is required for 9D3 powder developer. It should perform effectively provided it is kept dry and free from contamination with penetrant. Operators handling parts before and after application of dry developing powder must have very clean hands. Remove gloves used for handling parts in the penetrant and penetrant remover solution.

(2) Before exposing parts to developing powder, take care to ensure that parts are perfectly dry and free from any wet surface penetrant which could contaminate the developing powder.

I. Handling Data For ARDROX Materials

(1) ARDROX fluorescent penetrant inspection process materials are nonflammable or have flash points in excess of 125°F (52°C) and, therefore present no fire hazard under the stipulated conditions of use.

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(2) However, these materials can contain surface active agents and solvents that can exert a de-fatting action on the skin. Accordingly, it is good practice for operators to wear protective gloves made of polyvinal chloride or neoprene when working with fluorescent penetrant inspection materials.

(3) If the skin becomes contaminated, immediately wash thoroughly with soap and water and apply an emollient cream.

9. Inspection Procedure

A. Surface Preparation

(1) Thoroughly clean each part to be inspected. Surfaces should be free of foreign material including cleaning agents which might prevent adequate penetration of discontinuities or might hold penetrant and cause non-relevant indications. Removal of paint by volatile paint removers is not recommended because paint remover and dissolved paint may enter discontinuities, thus preventing adequate penetration of fluorescent material.

(2) Oil must be removed by degreasing. Dirt and scale must be removed by cleaning or blasting. Any blasting used for cleaning must be of type that would not smear over or close up surface openings.

(3) Discontinuities must be free of strong caustic and acid materials. Parts must dry before applying penetrant.

B. Penetration

(1) Immerse parts in tank containing fluorescent penetrant. In some cases penetrant may be sprayed on parts or manually applied with a brush. If required, this will be noted in method used. Penetrant is drawn into discontinuity by capillary action. As required, part is then put on a drain rack to permit excess penetrant to drain back into tank. Time on drain rack may be included in penetration time. If part is on drain rack for more than allowed time, reapply penetrant just prior to washing.

WARNING: OIL PENETRANT IS A SKIN IRRITANT. OPERATORS SHOULD WEAR NEOPRENE GLOVES AND USE MECHANICAL EQUIPMENT.

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(2) Where inspection directs its use, penetrant on part must be completely covered by either a post emulsifier or a penetrant remover. If application of the post emulsifier or the penetrant remover, draining, and water washing exceeds allowed time, inspection procedure must be recycled from first operation.

C. Washing

(1) The surface film of penetrant must be cleaned from part after penetration time has elapsed. Parts will be washed with either cold or warm water. Wash parts by spraying with cold water, or by dipping or spraying with warm water 120° to 130°F (49° to 54°C), as specified. A combination of dipping and spraying may be used. Use of spray nozzle is essential since penetrant is readily emulsified by physical action of water droplets. Water may be removed by a mild air blast prior to drying. Washing should be checked under black light to assure complete cleaning of surfaces.

D. Drying

(1) After washing parts, allow specified time interval for booth or oven drying and for development of fluorescent indications.

(2) Drying time in a recirculating hot air dryer varies depending on size and shape of part.

NOTE: Temperature of parts should not exceed that at which they can be comfortably handled without gloves. Excessive drying time or temperature interferes with development of adequate indications.

E. Developing

(1) Dry developers are powder preparations which may be applied to the test area by immersion in a tank of dry powder, brushing, or low-pressure air spraying. The developers should be light and fluffy, easily applicable in thin even coats, capable of masking out interfering background colors, easily wet by the penetrant, readily removable, and neither toxic nor harmful to the operator.

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(2) Wet developers are liquid preparations with hygroscopic characteristics. These developers are applied to the surface of the part by immersion, brushing, or spraying. The part must then be allowed to dry in air or in a controlled recirculating warm air dryer. The wet developers must also be readily removable and neither toxic nor harmful to the operator.

F. Inspection

(1) Parts must be inspected with black light in a darkened area or booth unless noted otherwise. Small parts may be held under a fixed black light. Use a portable hand black light over surface of large parts. Discontinuities will be shown by fluorescence of penetrant where is has developed out of flaw. Where required, a magnifying glass of four to ten power is used.

(2) Circle indications and questionable areas with a red pencil. Disposition of parts which contain discontinuities as indicated by fluorescent penetrant indications shall be made by experienced engineering personnel.

10. Service Process Operations Procedures (SPOP)

(1) The following methods are to be used with reference to Paragraph 1 through 9. Each part must be totally inspected.

NOTE: Reference to a SPOP number shall be interpreted to mean the latest revision of a SPOP as indicated by letter suffix.

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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
INDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

INSTRUCTURAL SUPPLEMENT #3--Magnetic Particle Inspection

1. General

A. Magnetic particle inspection is a nondestructive means of testing steel parts for imperfections at or near the surface. It is used to supplement visual inspection for specified parts The following procedures are based on use of wet residual method of inspection These instructions are not intended for use with wet continuous method of inspection except as specifically indicated.

B Complete inspection procedures shall include inspecting parts, tabulating nature and extent of imperfections, and final decision as to suitability of parts for further use. Inspectors shall be specialists who have been thoroughly trained to evaluate correctly the various indications.

C. Definitions:

(1) Imperfection - shall be used in these instructions to imply any nonhomogeneity of the material inspected as revealed by a magnetic particle indication.

(2) Defect - shall imply that the imperfection has been evaluated and a decision made by competent personnel that the part is not suitable for engine operation.

(3) Indication - shall be used when referring to the magnetic particle pattern produced by this inspection method where imperfections are present.

2. Method

A. Tools, amperages and procedures given in detail apply to direct current residual magnetization except as specifically indicated.

B. Induced current method of magnetization, using circular part as a shorted turn, is an approved procedure.

C. Alternating current continuous magnetization is an approved procedure. When alternating current continuous magnetization is used, operator must be responsible for development of equivalent amperage and procedures.

3. Description

Magnetic particle inspection depends on the magnetic field which is established when a part is magnetized. A clean part is magnetized directly by passing electric current through part, or indirectly by placing part in a magnetic field. Magnetized part is then immersed in a suspension containing finely divided magnetic particles. An imperfection in the part will cause magnetic leakage fields and consequently form an accumulation of particles. This pattern must be interpreted and evaluated. Records shall be maintained. Finally, part is demagnetized, cleaned, and preserved.

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4. Equipment and Materials for Suspensions

A. Equipment

(1) Equipment manufactured by Magnaflux Corporation, or Ferroscope Company, is commonly used. It must have sufficient capacity to produce required amperage. Fixtures and adapters must be used as necessary to properly inspect parts.

CAUTION: EQUIPMENT WHICH WILL ARC AND CAUSE BURNING OF ENGINE PARTS MUST NOT BE USED. IF A PART IS BURNED THE CAUSE MUST BE DETERMINED AND CORRECTIVE ACTION TAKEN.

(2) A special combination induced current and knife switch coil fixture, Magnaflux Corporation Model X-2152, or equivalent, may be used for induced current or knife switch coil methods of magnetization.

(3) Alternate equipment which may be used for steel compressor blades is the Magnaflux Corporation, Duovec Machine Model MV-1733, or equivalent.

(4) Tanks of sufficient size to accommodate parts being inspected shall be used to hold materials in suspension.

(5) Special tools used as needed depending on size of parts are as follows:

PWA-9400 Rod

PWA-9404 Solenoid - 2 inches Diameter (Magnaflux P/N 74610)

PWA-9405 Solenoid - 4 inches Diameter (Magnaflux P/N 74615)

PWA-9406 Solenoid - 6 inches Diameter (Magnaflux P/N 74620)

PWA-9407 Solenoid - 8 inches Diameter (Magnaflux P/N 74625)

PWA-9408 Solenoid - 10 inches Diameter (Magnaflux P/N 74630)

PWA-9409 Solenoid - 12 inches Diameter (Magnaflux P/N 74635)

B. Materials for Suspensions

(1) For MAGNETIC particle inspection, magnetic substance used shall be a material such as Magnaflux No. 7C or Testing Systems No. C-29B Black Powder, Magnaflux No. 7B Black Paste, or Magnaflux No. 9C Red Powder, or equivalents.

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(2) For FLUORESCENT MAGNETIC particle inspection, magnetic substance used shall be a water suspendible material such as Magnaglo Powder No. 20 or 20A, or Testing Systems Powder No. C-30F, or an oil suspendible material such as Magnaglo Powder No. 14A or Testing Systems Powder No. C-29F, or equivalents.

(3) Magnetic substance shall be suspended in a vehicle conforming to PMC-9001 or 9014 or a water suspension containing suitable wetting agents and rust preventives.

C. Maintenance of Equipment and Materials

(1) At beginning of each eight hour period of use, scrape bottom of tanks to loosen material which has settled. During use agitate solution in order to maintain a uniform mixture and minimize settling.

(2) Check concentration of magnetic substance in each tank at least once during each eight hour period of use and at least one hour after scraping. Fill clean 100 ml. graduated centrifuge tubes to 100 ml. mark with a sample from each tank and demagnetize. Allow contents to stand for 30 to 45 minutes as applicable, and then tap lightly on sides to level settled material.

(a) Volume of oil suspendible magnetic powder or paste, as settled for 45 minutes, shall not be less than 1.3 ml. or more than 1.8 ml.

(b) Volume of oil suspendible fluorescent magnetic powder, as settled for 45 minutes, shall not be less than 0.1 ml. or more than 0.5 ml.

(c) Volume of water suspendible fluorescent magnetic powder, as settled for 30 minutes, shall not be less than 0.1 ml. or more than 0.5 ml.

(3) Periodically check solution in each tank for contamination by foreign materials.

(4) Viscosity

(a) Total addition of all material to the liquid vehicle shall not raise the viscosity of the suspension above 5.0 centistokes (42.5 SUS) at any temperature at which the bath may be used. Since contamination will be proportion to degree of use, test frequencies will vary, but, in any case, must be conducted at least once every six months.

(5) Check equipment daily for loose connections or grounds, short circuits, and proper operation. Make a daily check of a test part with known defects to determine that satisfactory results are obtained. Make necessary repairs and adjustments to equipment and materials prior to inspecting engine parts. Check ammeters once each month for accuracy.

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5. Preparation of Parts

Disassemble and clean all parts thoroughly. Remove all scratches, scoring, and galling with stones or fine crocus cloth and oil. Cap all oil passages. Polish contact areas of all parts in order to minimize burning due to poor electrical connections. Do not remove entire protective finish solely for magnetic inspection. If finish is to be replaced because of flaking, peeling or established procedure, inspect part after finish is removed.

6. Magnetization

A. Magnetize each part with specified current density for one-fifth to one-half second for each charge. A longer time wastes current and increases danger of burning. Use controlled procedures in order to achieve a uniform magnetic flux of suitable density and direction in all parts. Do not allow actual amperage to vary more than plus or minus 20 percent from amperage specified in particular method. Adjust machine to obtain the proper amperage. Make sure all contacts are clean and tight. Do not release contact pressure until ammeter indicates zero.

B. Circular magnetization is achieved by passing a high amperage, low voltage charge directly through part. On hollow parts a central conductor rod can be used. On disk and ring shaped parts, the induced current method can be used, with appropriately modified procedures, in place of direct contact "shot" across OD to eliminate danger of contact burning.

C. Longitudinal magnetization is achieved by placing part in a solenoid carrying a direct current, interrupted by a fast break. A sufficient number of shots must be given to cover entire length of part.

7 Immersion

A. Immerse magnetized part in applicable suspension for a period of thirty seconds to two minutes Be sure suspension complies with established requirements for concentration of finely divided magnetic particles and is being agitated.

B. Parts in baskets or on straps must not be touching each other. Circulation of fluids in the basket shall not be interfered with by construction of basket.

8. Inspection

A. Visually inspect part after each immersion for magnetic particle indications. For fluorescent magnetic particle inspection, use a suitable hooded booth or similar darkened area with "black light" with an intensity of 200 foot candles and a wave length of 3600 angstrom units.

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B. Each part must be totally inspected. Inspect part completely, paying particular attention to lugs, bosses, webs, splines, teeth, flanges, shoulders, slots or other intricate areas.

NOTE: Whenever the ID of a shaft or hole cannot be inspected directly by eye, use a mirror and light or a borescope.

C. Identify imperfections and record necessary information. Final disposition of parts which have any discontinuities must be made by experienced engineering personnel. Mark or tag parts as necessary. Do not reject parts with irrelevant indications caused by minor surface pits and scratches which would be acceptable by visual inspection.

9. Demagnetization

A. Procedure

(1) Use following procedure to demagnetize parts after completing inspection, and when noted in specific method:

(a) Pass parts through entire length of demagnetizer.

(b) Hold parts close to top or sides of demagnetizer.

(c) Withdraw parts slowly.

(d) Rotate circular parts while withdrawing.

(e) Remove parts straight away from demagnetizer, and do not turn current off until parts are at least three feet from demagnetizer.

B. Demagnetization Test (Compass Method)

NOTE: Perform this test at least on first piece of each lot of parts and not less than once on each shift. Optional to Field Strength Indicator method.

(1) Use a good quality pocket compass with approximately a one and one-half inch needle and a one and three-quarters to one and seven-eighths inch case to test for satisfactory demagnetization. Do not use a compass with an abnormal or sluggish needle. Test each part, using the applicable method, for satisfactory demagnetization. If compass needle does not turn end for end when proper method is used, part is satisfactorily demagnetized.

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(2) General Method - Place compass on a wooden bench. Move part along its major axis in an east-west direction past north or south side of compass keeping part in contact with compass case.

(3) Method for Large or Heavy Parts. For large or heavy parts, place part with its major axis in an east-west direction, on a wooden bench in an area where local magnetic field does not deflect compass more than 10 degrees. Move compass along north or south side of part keeping compass in contact with part.

(4) Method for Circular Parts. Place compass on a wooden bench. Hold part in contact with north or south side of compass and rotate part 360 degrees.

C. Demagnetization Test (Field Strength Indicator Method)

NOTE: Perform this test at least on first piece of each lot of parts and not less than once on each shift. Optional to Compass Method.

(1) Using a magnetic field strength indicator, such as is available from Magnetic Analysis Corporation, 535 South 4th Avenue, Mt. Vernon, New York 10553, check for satisfactory demagnetization.

(2) Place indicator in contact with part with sides of meter adjacent to pivot end of pointer touching part.

(3) Move meter over all areas of part, particularly top and bottom rims of flanges and all projections from main body.

(4) Watch needle of indicator during this procedure. Needle should not deflect more than two divisions from its point of rest if part is properly demagnetized.

10. Cleaning and Preserving

A. After demagnetizing, remove all magnetic substance from accepted parts. Coat all parts with engine oil or corrosion preventive oil.

11. Specified Procedures

A. Engine parts that require magnetic particle inspection are listed with sequence of magnetization, amperage, applicable special tools and method (Service Process Operation Procedure) to be used. See inspection sections of engine manuals.

B. Parts requiring fluorescent magnetic particle inspection are so designated. For those parts which are not so designated, either nonfluorescent or fluorescent magnetic particle inspection may be used.

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12. Service Process Operation Procedures (SPOP)

NOTE: Reference to a SPOP number shall be interpreted to mean latest revision of a SPOP as indicated by letter suffix.

A. SPOP 101A

(1) Degrease if necessary.

(2) Magnetize circularly, rotating eccentrically on an insulated copper rod.

NOTE: When magnetizing parts with blind inside diameters, install the PWA-9400 Rod in the open end. Clamp the rod and part between the heads of the machine. No rotation of these parts is required.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Record inspection.

(6) Demagnetize.

(7) Wash with PMC-9010.

(8) Coat part with a thin film of corrosion preventive oil PMC-9101.

B. SPOP 102A

(1) Degrease if necessary.

(2) Magnetize circularly, rotating eccentrically on an insulated copper rod. (Use first amperage number).

NOTE: When magnetizing parts with blind inside diameters, install PWA-9400 Rod in open end. Clamp rod and part between heads of machine. No rotation of these parts is required.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

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(4) Inspect visually.

(5) Magnetize longitudinally in a solenoid. (Use second amperage number.)

NOTE: Use PWA solenoid with ID next larger than OD of part. Parts longer than solenoid are to be given sufficient shots to cover their entire length.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

(8) Record inspection.

(9) Demagnetize.

(10) Wash with PMC-9010.

(11) Coat part with a thin film of corrosion preventive oil PMC-9101.

C. SPOP 103B

(1) Degrease if necessary.

(2) Magnetize circularly, rotating eccentrically on an insulated copper rod. (Use first amperage number.)

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Magnetize circularly by contacting on OD. (Use second amperage number.)

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

(8) Record inspection.

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(9) Demagnetize.

(10) Wash with PMC-9010.

(11) Coat part with a thin film of corrosion preventive oil PMC-9101.

D. SPOP 105A

(1) Degrease if necessary.

(2) Magnetize circularly, contacting on ends.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Record inspection.

(6) Demagnetize.

(7) Wash with PMC-9010.

(8) Coat part with a thin film of corrosion preventive oil PMC-9101.

E. SPOP 106A

(1) Degrease if necessary.

(2) Magnetize circularly contacting on ends. (Use first amperage number.)

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Magnetize longitudinally in a solenoid. (Use second amperage number.)

NOTE: Use PWA solenoid with ID next larger than OD of part. Parts longer than solenoid are to be given sufficient shots to cover their entire length.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

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(7) Inspect visually.

(8) Record inspection.

(9) Demagnetize.

(10) Wash with PMC-9010.

(11) Coat part with a thin film of corrosion preventive oil (PMC-9101).

F. SPOP 107A

(1) Degrease if necessary.

(2) Magnetize longitudinally in a solenoid.

NOTE: Use P&WA solenoid with ID next larger than OD or part. Parts longer than solenoid are to be given sufficient shots to cover their entire length.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Record inspection.

(6) Demagnetize.

(7) Wash with PMC-9010.

(8) Coat part with a thin film of corrosion preventive oil PMC-9101.

G. SPOP 108B

(1) Degrease if necessary.

(2) Magnetize longitudinally using an eight inch diameter solenoid. (Use first amperage number.)

NOTE: Give sufficient number of shots to cover length as applicable.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

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(4) Inspect visually.

(5) Magnetize by induction. (Use second amperage number.)

NOTE: The largest soft iron core available that will pass through the ID of the part to be inspected must be used.

(a) Manual Method - Wrap three turns of 0000 cable around flange OD. Insert transformer core in bore.

(b) Fixture Method - Center shaft on induced current portion of fixture. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

(8) Demagnetize.

(9) Magnetize shaft portion circularly by rotating eccentrically on an insulated copper rod. (Use third amperage number.)

(10) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(11) Visually inspect shaft portion.

(12) Magnetize large OD portion circularly by rotating eccentrically on an insulated copper rod. (Use fourth amperage number.)

(13) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(14) Visually inspect the large OD portion.

(15) Demagnetize.

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(16) Record inspection.

(17) Wash with PMC-9010.

(18) Coat part with a thin film of corrosion preventive oil PMC-9101.

H. SPOP 112B

(1) Degrease if necessary.

(2) Magnetize circularly. (Use first amperage number.)

(a) Manual Method - Wrap 0000 cable through bore four turns. Give one shot of required amperage.

(b) Fixture Method - Place disk on knife switch portion of the fixture. Give one shot of required amperage.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

Inspect all magnetic compressor disks, and all magnetic turbine disks by using fluorescent magnetic particle inspection.

(4) Inspect visually.

(5) Magnetize by induction. (Use second amperage number.)

NOTE: The largest soft iron core available that will pass through the ID of the part to be inspected must be used.

(a) Manual Method - Wrap three turns of 0000 cable around disk OD. Insert transformer soft iron core in disk bore. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(b) Fixture Method - Center disk on induced current portion of fixture. Magnetize disk with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

Inspect all magnetic compressor disks, and all magnetic turbine disks using fluorescent magnetic particle inspection only.

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(7) Inspect visually paying special attention to blade contact areas. Use of a small mirror in each slot is recommended.

(8) Record inspection.

(9) Demagnetize.

(10) Wash with PMC-9010.

(11) Coat part with a thin film of corrosion preventive oil PMC-9101.

I. SPOP 115

(1) Degrease if necessary.

(2) Magnetize circularly, rotating eccentrically on an insulated copper rod. (Use first amperage number.)

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Magnetize by induction. (Use second amperage number.)

NOTE: The largest soft iron core available that will pass through the ID of the part to be inspected must be used.

(a) Manual Method - Wrap three turns of 0000 cable around OD. Insert transformer core in center of part. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(b) Fixture Method - Center part on induced current fixture. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

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(8) Demagnetize.

(9) Record inspection.

(10) Wash with PMC-9010.

(11) Coat part with a thin film of corrosion preventive oil PMC-9101.

J. SPOP 116

(1) Degrease if necessary.

(2) Magnetize by induction. (Use first amperage number.)

NOTE: The largest soft iron core available that will pass through the ID of the part to be inspected must be used.

(a) Manual Method - Wrap three turns of 0000 cable around OD. Insert transformer core in bore. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(b) Fixture Method - Center part on induced current fixture. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Magnetize longitudinally in a solenoid. (Use second amperage number.)

NOTE: Use PWA solenoid having ID next larger than OD of part. Parts longer than solenoid are to be given sufficient shots to cover their entire length.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

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(8) Demagnetize.

(9) Magnetize circularly. (Use third amperage number.)

(a) Manual Method - Wrap 0000 cable through bore three turns. Magnetize with direct current for one-fifth to one-half second with "Quick Break" switch in circuit.

(10) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(11) Inspect visually.

(12) Record inspection.

(13) Demagnetize.

(14) Wash with PMC-9010.

(15) Coat part with a thin film of corrosion preventive oil PMC-9101.

K. SPOP 117A

NOTE: Use only DC rectified current, continuous method, with fluorescent magnetic particle suspension.

(1) Degrease.

NOTE: Flow-Turned cases do not have an axial weld, therefore, steps (2) and (3) are omitted.

(2) Magnetize circularly by applying 3500 amperes direct current through a single 0000 cable or insulated bar held to OD of case assembly adjacent to axial weld and extending 10 inches beyond front and rear flange. Apply fluorescent magnetic particle suspension (SPS No. 8, see step (10).) to cover an area 10 inches maximum above and below cable or rod location as current is being applied (Continuous Method).

NOTE: If necessary, to remove excessive fluorescent background, gently dip part in tank containing 25 parts water and one part PMC-9550 Addition Agent.

After OD area of case specified above is covered, ID equivalent area may be covered in a similar manner.

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(3) Inspect axial weld area both ID and OD using 100 watt black light and three power magnification.

(4) Record inspection.

(5) Repeat process by placing cable or rod along case adjacent to fuel drain bosses, and at four additional locations spaced approximately 60° apart or 20 inches apart so that complete case is circularly inspected.

(6) Magnetize case assembly longitudinally, using one of following methods:

(a) Wrap two turns of number 0000 cable around case at rear flange and apply 2500 amperes direct current (Continuous Method). Apply fluorescent magnetic particle suspension (SPS No. 8, see step (10).) to OD and ID of part.

NOTE: If necessary to remove excessive fluorescent background, gently dip part in tank containing 25 parts water and one part PMC-9550 Addition Agent.

Inspect entire area of rear third of case, using a 100 watt black light. Three power magnification of axial and circumferential welds and of rear flange radius shall be used. Record results of inspection.

Move coil to center and then to front flange of case, repeating magnetization and inspection procedure specified above to cover middle and front third of case assembly.

(b) Install combustion chamber outer case assembly rear flange down over laminated soft iron core of a Magnetizing Fixture (Induced Current), Model X-2152, manufactured by Magnaflux Corporation, Chicago, Illinois, or equivalent. Position case off center in relation to core and rotate 360 degrees while applying 1000 amperes direct current (Continuous Method). Apply fluorescent magnetic particle suspension (SPS No. 8, see step (10).) to OD and ID of case.

NOTE: If necessary to remove excessive fluorescent background, gently dip part in tank containing 25 parts water and one part PMC-9550 Addition Agent.

Inspect entire area of rear half of case, using a 100 watt black light. Three power magnification of axial and circumferential welds and of rear flange radius shall be used. Record results of inspection.

Invert case and repeat magnetization and inspection procedures specified above to cover front half of case.

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(7) Demagnetize by rotating case adjacent to largest available demagnetizer.

(8) Wash with PMC-9010.

(9) Coat part with a thin film of corrosion preventive oil PMC-9101.

(10) SPS No. 8

  (a) Fill container with required amount of water and add one part by volume Immunol No. 438, PMC-9550, for every 25 parts of water.

  (b) Stir to mix.

  (c) Add one ounce of Magnaglo Powder No. 20 (SPMC-8), or No, 20A, or Testing Systems Powder No. C-30F, or equivalent, for each gallon of solution.

  (d) Stir to mix.

L. SPOP 118 Magnetic Particle Inspection (Vane and Shroud Weldments)

(1) Degrease if necessary.

(2) Magnetize circularly contacting across each vane on inner and outer shroud. (Use first amperage number).

CAUTION: AVOID CONTACT OF INNER SHROUD SEAL.

NOTE: Where vanes are close together, one shot may include two or more vanes. Positive contact at inner and outer shroud will prevent burning.

(3) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(4) Inspect visually.

(5) Magnetize by induction. (Use second amperage number.)

  (a) Manual Method - Wrap three turns of 0000 cable around OD of two mated vane and shroud halves. Insert transformer core in center of assembly. Magnetize with direct current for 1/5 to 1/2 second with "Quick Break" switch in circuit.

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(b) Fixture Method - Center two mated vane and shroud halves on induced current fixture. Magnetize with direct current for 1/5 to 1/2 second with "Quick Break" switch in circuit.

(6) Immerse in iron oxide suspension or flow on as suitable.

NOTE: If necessary, when using fluorescent magnetic particle suspension only, gently dip part in PMC-9001 petroleum solvent to remove excessive fluorescent background.

(7) Inspect visually.

(8) Record inspection.

(9) Demagnetize.

(10) Wash with PMC-9010.

(11) Apply a thin film of corrosion preventive oil PMC-9101.

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GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

INSTRUCTIONAL SUPPLEMENT #4--X-ray Inspection

1. General

A. The penetrating power of X-ray radiation is utilized to reveal the interior of objects as recorded on film, and thereby the presence of discontinuities. The procedures in this section include preparation for exposure, exposure of film, film processing, and interpretation of radiographs.

B. The basic elements of the system are depicted in Figure 1. Radiation passes through the object and produces a latent image on the film. When processed, the film becomes a radiograph, or shadow picture of the object. Since more radiation passes through the object where the section is thinner, or where there is a space or void, or where there is less dense material, the corresponding area on the film is darker. The radiograph is read or interpreted by comparing it with the known nature of the object.

C. Although radiography will reveal the interior of opaque objects, it cannot detect all types of discontinuity. Small defects in thick objects such as fine cracks or laminations are difficult to detect. Limitations of this technique, as well as sensitivity in individual applications, must be kept constantly in mind.

D. Safety

(1) While most X-ray equipment is designed to minimize the danger of exposure harmful to personnel, it is essential that adequate measures be taken to protect persons who work with or are near X-ray equipment. These measures may include warning signs, labels, and signals, interlocked enclosures, shielding, the use of survey meters, and monitoring devices such as dosimeters and film badges.

(2) Facilities should comply with the American National Standards Institute (ANSI) Z 54.1 Safety Standard for Nonmedical X-ray and Sealed Gamma-Ray Sources, also designated National Bureau of Standards Handbook 93, Part I (U.S. Department of Commerce). This booklet is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. It may also be ordered from the American National Standards Institute, 1430 Broadway, New York, N. Y. 10018.

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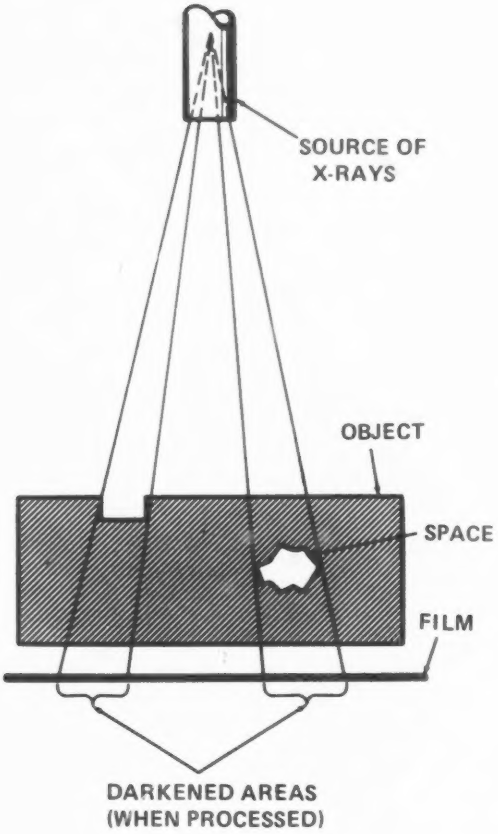
INSTRUCTIONAL SUPPLEMENT #4


SOURCE OF
X-RAYS
OBJECT
SPACE
FILM
DARKENED AREAS
(WHEN PROCESSED)

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(3) Rules and regulations pertaining to personnel exposure are contained in the Occupational Safety and Health Administration (OSHA) Standards as published in the Federal Register CFR, Title 29, Chapter XVII, paragraph 1910.96. This publication may also be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from any regional office of the U.S. Department of Labor.

(4) Compliance must also be observed with all State and/or local public health regulations.

E. Terminology

(1) Braze mating area - that area common to both parts into which braze is scheduled to flow.

(2) Brazed assembly acceptance limit - indications of cracks or voids in the braze material shall not be accepted unless so provided in the specific repair instruction.

(3) Brazed joint length - the length of the joint area required to be brazed as measured from the actual inner joint end to the outer joint end, or as specified in a repair instruction.

(4) Braze-filled crack - occurs when braze material, normally of greater density than parent metal, flows into a crack which is open at the surface. It is shown radiographically as a crack indication of low radiographic density, i.e. the reverse radiographic density of a normal crack indication.

(5) Crack - a narrow break or fissure caused by internal stresses, external stresses, or fatigue acting independently or in combination. Cracks may occur at any time during or after the solidification of molten material.

(6) Cold crack (stress crack, fatigue crack) - occurs due to internal and/or external stresses when the metal is in solid form. It is shown radiographically as a relatively straight line of higher radiographic density which is smooth and well defined, or in the event the crack follows grain boundaries, it may show some irregularity.

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TECHNICAL INFORMATION SUPPLEMENT #1--Terms and Definitions Related to Structural Materials

A. Brittleness--Property of a metal to break when bent, deformed, or hammered; or resistance to change in the relative position of the molecules within the material

B. Density--Mass of a substance per unit of its volume; weight per unit volume expressed in pounds per cubic foot

C. Toughness--Property of a metal which allows it to be deformed without breaking

D. Bearing strength--Force required to pull a rivet through the edge of the sheet or to elongate the hole

E. Shear strength--Amount of force required to shear a pin, bolt, or rivet

F. Yield strength--Load on a material, which causes the initial indication of permanent distortion

(NOTE: Yield strength is expressed in pounds per square inch.)

G. Tensile strength--Ability of an object to resist forces tending to stretch or lengthen it

H. Elasticity--Capability of an object or material to be stretched and to recover its size and shape after its deformation

I. Ductility--Property which allows metal to be drawn into thinner sections without breaking

J. Malleable--Characteristics of material that allows it to be stretched or shaped, by beating with a hammer or passing through rollers, without breaking

K. Thermal expansion--Expansion of any substance due to heat

L. Fusibility--Ability of a material to be fused or welded

M. Thermal conductivity--Characteristic of a material to carry heat with a minimum loss

N. Electrical conductivity--Characteristic of a metal to conduct electricity with a minimum of opposition or resistance

O. Hardness--Property of a metal that enables it to resist penetration, wear, or cutting actions

P. Ferrous metal--Metal which contains iron

Q. Nonferrous metal--A metal which contains no iron

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
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TECHNICAL INFORMATION SUPPLEMENT #2--Terms and Definitions Related to Nondestructive Testing

A. Liquid-penetrant/dye-penetrant inspection--Method of detecting surface cracks in which a penetrating liquid dye is allowed to enter any cracks present, and is pulled out of the crack by an absorbent developer; crack appears as a line on the surface of the developer

B. Eddy current inspection--Comparison-type of nondestructive inspection, based on the difference in induced magnetic conductivity of a sound and a defective part

C. Magnetic particle inspection--Form of nondestructive inspection for ferrous metal parts in which the part is magnetized, producing north and south poles across any discontinuity, either on the surface or subsurface; iron oxide is attracted and held over the discontinuity

D. Radiography--System of nondestructive inspection using X-rays or gamma rays to determine the condition of a part not visible without disassembly

E. Ultrasonic inspection--Form of nondestructive inspection in which the condition of a material is determined by its ability to conduct vibrations normally at frequencies above those to which the human ear responds

F. Visual inspection--Inspection of a part or component by visual means only; inspection by magnification using a 10X-20X magnifying glass

G. X-ray--Electromagnetic radiation of extremely short wavelength, capable of penetrating solid objects and exposing photographic film

H. Fluorescent penetrant inspection--Form of nondestructive inspection in which a part is thoroughly cleaned and immersed in a vat of penetrating oil. When the part has soaked for a sufficient time; it is removed, the oil is washed from the surface, and the part is dried. It is then covered with a developer that will draw the oil from any crack into which it may have seeped. The part is inspected under ultraviolet light which will cause the crack to appear as a vivid green line

I. Fluorescent--Substance that will glow when excited by a black light

J. Developer (dye check)--Powder sprayed on a surface which has been treated with a penetrating dye. The powder acts as a blotter, pulling penetrant out of any crack, exposing the crack

K. Black light--Ultraviolet light whose rays are in the lower end of the visible spectrum. While more or less invisible to the human eye, these rays excite, or make visible, certain materials such as fluorescent dyes

L. Defect--Any imperfection, fault, flaw, or blemish which may require repair or replacement of a part

M. Emulsifier--Agent which will, when added or applied to an oil-like penetrant material, make the penetrant removable from surfaces by water rinsing

N. Water-washable material--Oil-like material containing an emulsifying agent which makes it washable by water rinsing

O. Post-emulsifiable material--Oil-like material which, after application to a surface, can be made water-washable by the application of an emulsifier

P. Penetrant remover--Solvent-type liquid used to clean penetrants from the surface of a material

Q. Penetrant sensitivity--Ability of the penetrant, processing technique, and developer to detect surface-connected discontinuities and provide an indication visible to the unaided eye

R. Discontinuity--Break or opening in the surface or subsurface of a material

TECHNICAL INFORMATION SUPPLEMENT #3--Advantages and Disadvantages of Various Inspection Methods

Method	Advantages	Disadvantages
Visual	1. Cheapness. 2. Portability. 3. Immediate results. 4. Minimum special skill. 5. Minimum part preparation.	1. Suitable only for surfaces which can be viewed. 2. Generally detects only larger defects. 3. Misinterpretation of cracks and scratches.
Radiographic X-ray	1. Ability to inspect for both internal and surface defects. 2. Ability to inspect parts covered or hidden by other parts or structure. 3. Permanent test record obtained. 4. Minimum part preparation required.	1. Most expensive. 2. Airplane may have to be defueled. 3. Area must be cleared of other personnel to avoid X-ray exposure. 4. Test method is highly directional, depends on crack/X-ray source orientation. 5. High degree of skill required for varied technique development and radiographic interpretation.
Radiographic Isotopes	1. It is portable. 2. Needs less area to gain access for energy source. 3. Can accommodate thicker material sources. 4. Less expensive than X-ray.	1. Must conform to Atomic Energy Commission regulations for handling and use.

TECHNICAL INFORMATION SUPPLEMENT #3

Method	Advantages	Disadvantages
Eddy Current	1. Portable 2. Moderate cost. 3. Immediate results. 4. Sensitive to small indication. 5. Little part preparation.	1. Essentially a surface inspection. 2. Surface to be inspected must be accessible to contact by the probe. 3. Rough surfaces interfere with test sensitivity. 4. Suitable for inspection of metals only. 5. No permanent test records. 6. Considerable skill and familiarity required in handling test equipment. 7. Time consuming to scan large areas.
Ultrasonic	1. Suitable for surface and subsurface defects. 2. Sensitive to small defects. 3. Immediate test results. 4. Little part preparation. 5. Wide range of material thicknesses can be inspected.	1. Surface of part to be inspected must be accessible to sonic probe. 2. Rough surfaces interfere with test results. 3. No permanent test record. 4. Test method is directional depending on sound beam-defect orientation. 5. High degree of skill and experience required to set up and interpret results for varied test conditions.
Liquid Penetrant	1. Cheapness. 2. Portable. 3. High sensitivity. 4. Immediate results. 5. Minimum skill required to perform.	1. Can only inspect surface of parts accessible to penetrant application. 2. Defects must be open to surface. 3. Part preparation, such as removal of finishes and sealant required. 4. No permanent test results. 5. Direct visual detection of results required. 6. Requires a high degree of cleanliness for satisfactory inspection.

Method	Advantages	Disadvantages
Magnetic Particle	1. Semiportable. 2. Sensitive to small indications. 3. Detects surface and near-surface defects. 4. Sensitive to inclusions as well as cracks. 5. Moderate skill required to perform.	1. Only suitable for ferromagnetic material. 2. Part must be physically and visually accessible to perform test. 3. Removal of most surface coatings and sealant required. 4. Inspection is semidirectional requiring a general orientation of field to defect. 5. No permanent test results unless the indications from dry powder technique are recorded by pressing Scotch tape on the surface. 6. Not usable in areas where a strong magnetic field may damage instruments. 7. Part must be demagnetized after inspection.

TECHNICAL INFORMATION SUPPLEMENT #4--Terms and Definitions Related to Magnetic Particle Inspection

A. Magnetic flux--Invisible lines of magnetic force that exist between the poles of a magnet

(NOTE: They are assumed to flow externally from the north pole of the magnet to its south pole. One line of magnetic flux is called one maxwell and is symbolized by the Greek letter [phi].)

B. Flux density--Number of lines of magnetic flux per unit area.

(NOTE: Its unit is the gauss. One gauss is equal to one maxwell per square centimeter.)

C. Retentivity--Ability of a material to retain some residual magnetism after the magnetizing force is removed

D. Coercive force--Reverse magnetizing force required to remove the residual magnetism from a material

E. Residual magnetism--Magnetism that remains in a material after the magnetizing force is removed

F. Permeability--Ease with which a material will conduct lines of magnetic flux

Density of Metals

Metal	Density	Weight of One Cubic Inch (Pounds)
Aluminum	2.7	0.0975
Titanium	4.4	0.159
Steel	7.9	0.285
Copper	8.9	0.321
Lead	11.4	0.412
Gold	19.3	0.697

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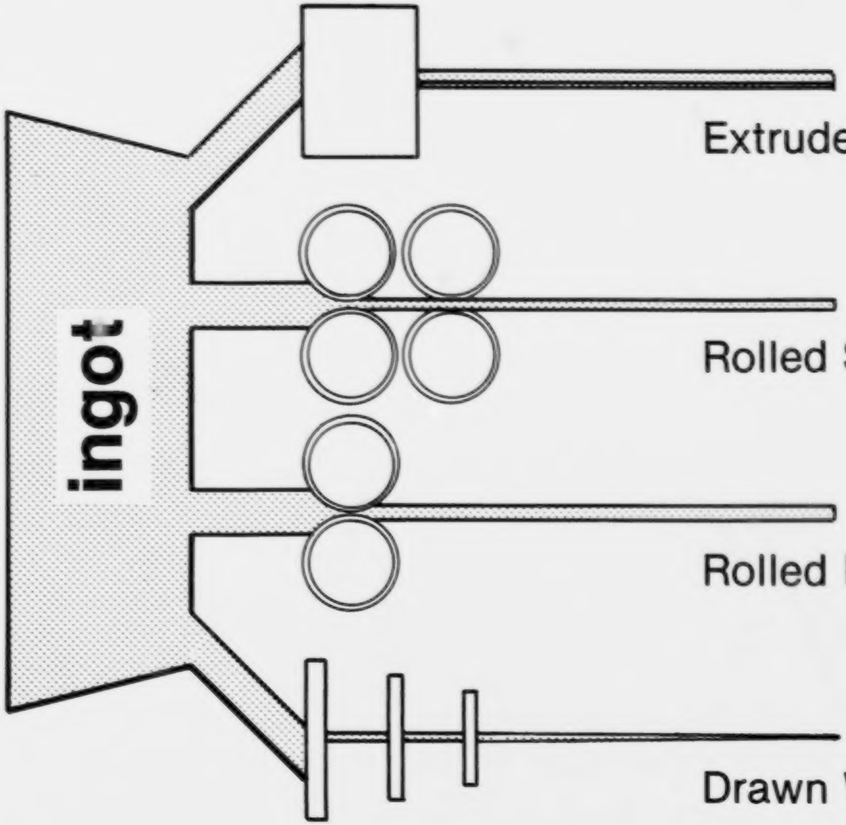
Types of Nonferrous Materials (Elements and Compounds)

Nonferrous Material	Chemical Abbreviation
A. Aluminum	Al
B. Copper	Cu
C. Zinc	Zn
D. Nickel	Ni
E. Tin	Sn
F. Glass	Not Applicable
G. Plastic	Not Applicable
H. Ceramic	Not Applicable
I. Magnesium	Mg
J. Lead	Pb
K. Titanium	Ti
L. Chromium	Cr
M. Manganese	Mn
N. Tungsten	W
O. Vanadium	V

TM #2

Methods of Finishing Refined Nonferrous Materials



Extruded Shapes and Tubing

Rolled Sheet, Plate, and Foil

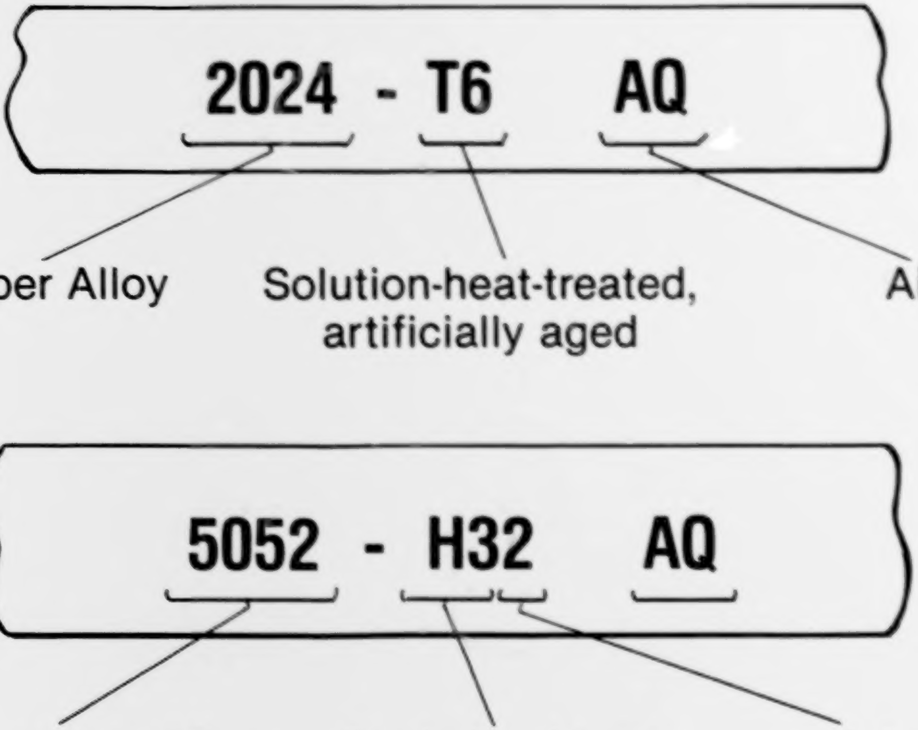
Rolled Rod and Bar

Drawn Wire

G102D-123

TM #3

Identification Markings



2024 - T6 AQ

Aluminum Copper Alloy

Solution-heat-treated, artificially aged

Aircraft Quality

5052 - H32 AQ

Aluminum-Magnesium Alloy

Strain-hardened, then stabilized

¼ hard

Alloying Elements of Aluminum

Non-Heat Treatable Alloy	Percent of Alloying Elements					
	Copper	Silicon	Manganese	Magnesium	Zinc	Chromium
1100						
3003			1.2			
5052				2.5		0.25
Heat-Treatable Alloy						
2017	4.0		0.5	0.5		
2117	2.5			0.3		
2024	4.5		0.6	1.5		
6061	0.25	0.6		1.0		0.25
7075	1.6			2.5	5.6	0.3

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Temper Designations

5052 - H 32 AQ

Temper Designation

		Heat Treatable	Nonheat Treatable
-O	Annealed	✓	✓
-F	As-Fabricated As-Cast	✓	✓
-T	Solution Heat-Treated (except T5)	✓	
-H	Strain-Hardened		✓

Temper Designations For Heat-Treatable Alloys

T3	Solution-heat-treated, followed by strain hardening.
T4	Solution-heat-treated, followed by natural aging at room temperature to a stable condition.
T5	Artificially aged after an elevated-temperature, rapid-cool-fabrication process.
T6	Solution-heat-treated, followed by artificial aging (precipitation-heat-treated).
T7	Solution-heat-treated, followed by stabilizing.
T8	Solution-heat-treated, strain-hardened, and then artificially aged.
T9	Solution-heat-treated, artificially aged, and then strain-hardened.

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Temper Designations For Non-Heat-Treatable Alloys

-H1 Strain-hardened temper produced by cold working the metal to the desired dimensions. The second digit indicates the degree of hardness:

-H12	Quarter-hard
-H14	Half-hard
-H16	Three-quarter hard
-H18	Full-hard
-H19	Extra-hard

-H2 Strain-hardened and partially annealed, to remove some of the hardness. The second digit indicates the degree of hardness and is the same as used in the -H1 classifications.

-H3 Strain-hardened and stabilized

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Alloying Agents In Steel

Carbon

Sulfur

Manganese

Silicon

Phosphorous

Nickel

Chromium

Molybdenum

Vanadium

Titanium

Tungsten

Safety Precautions To Be Used In Heat Treatment

A. Always wear goggles or face shield to protect face and eyes while working with heated materials

B. Always wear apron, gloves, and protective shoes to prevent burns from heated materials

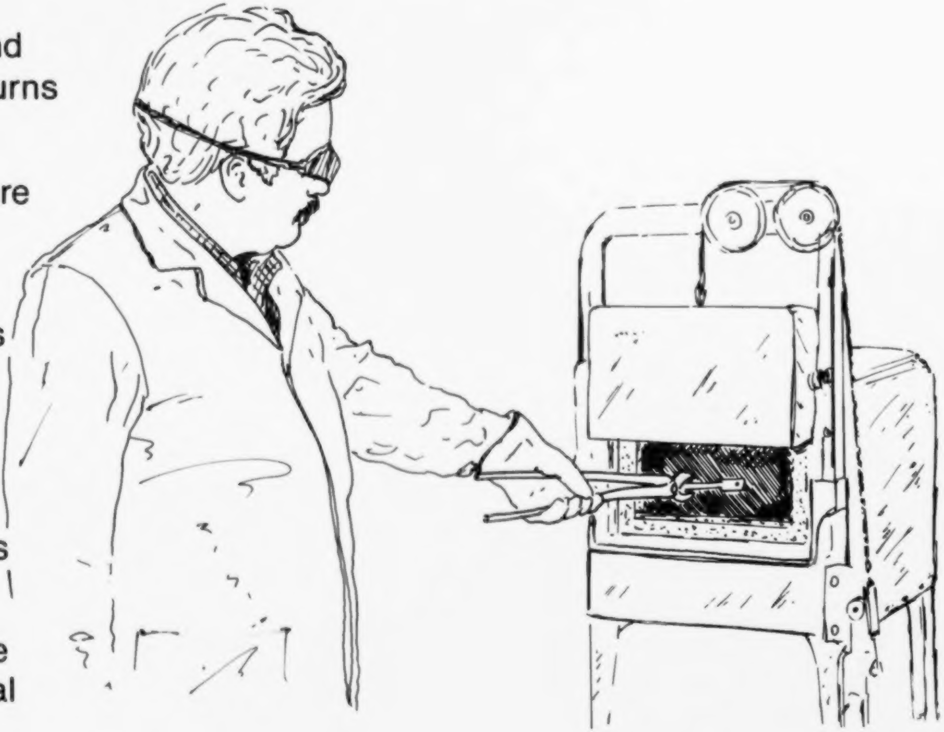
C. Follow demonstrated procedure in lighting gas furnaces

D. Always start air flow to gas furnace before turning on gas

E. If furnace fails to light, clear the fumes with airflow before relighting

F. Know the *off* and *on* positions of the gas valve

G. Shut off electric circuit before inserting or removing material from an electric furnace

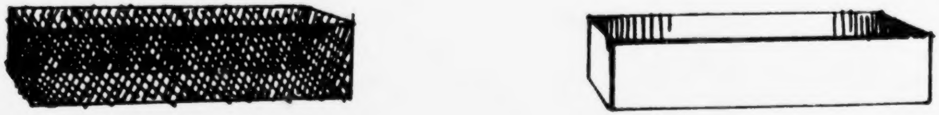


Safety Precautions To Be Used In Heat Treatment

(Continued)

H. Use proper size and type of tongs to remove and insert material into a heated furnace

I. Make sure containers are large enough and sturdy enough to support material items



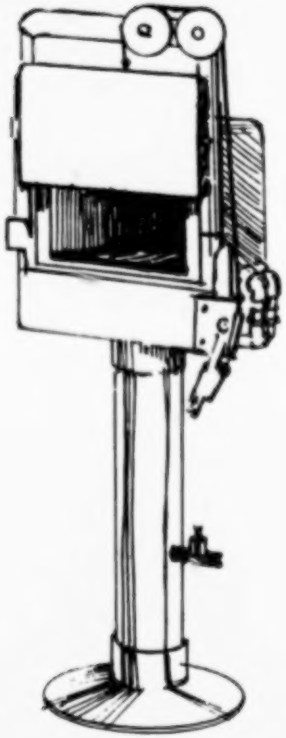
J. Use large enough quench tanks to prevent overheating the quenching medium

(DANGER: Hot water may cause burns. Oil baths must be kept below kindling temperatures.)

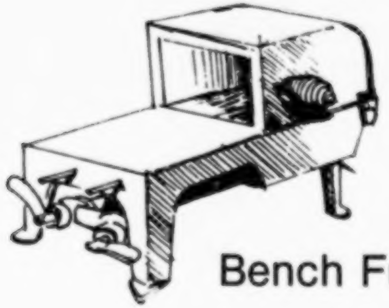
K. Always dry tongs and ladles before using them in a salt bath solution

(DANGER: Water will create steam and result in blowing out hot salt from the heated bath.)

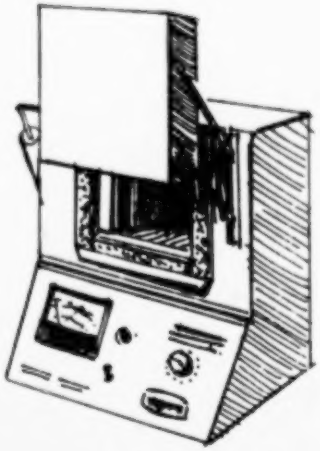
Types of Heating Mediums



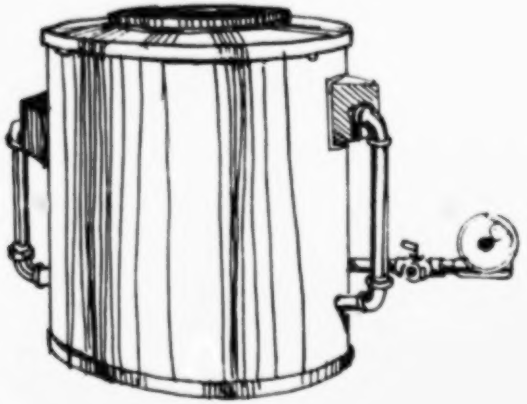
Gas Furnace



Bench Furnace



Electric Furnace

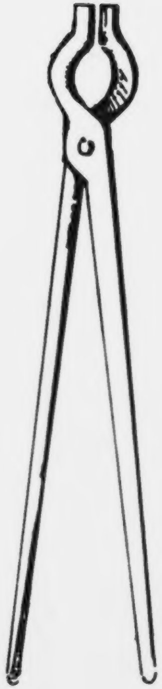


Pot Furnace

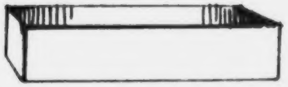
G102D-141

TM #12

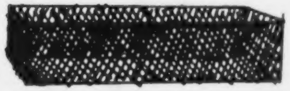
Heat-Treating Instruments



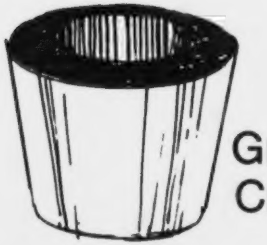
Tongs



Metal Tray

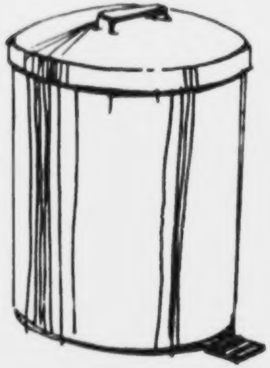


Wire Tray



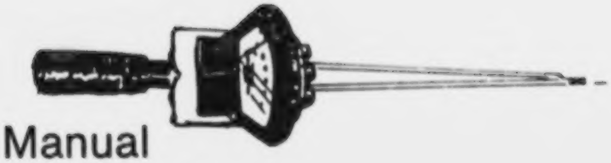
Graphite Crucible

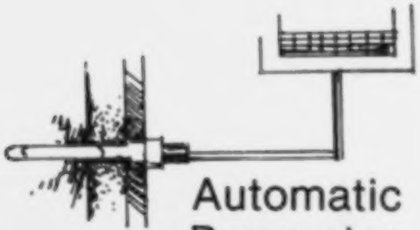
Containers



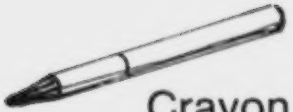
Quench Tank

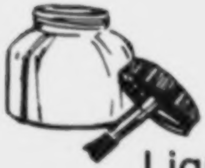
Heat-Treating Instruments
(Continued)

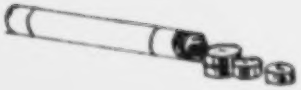

Manual Pyrometer


Automatic Pyrometer

Pyrometers

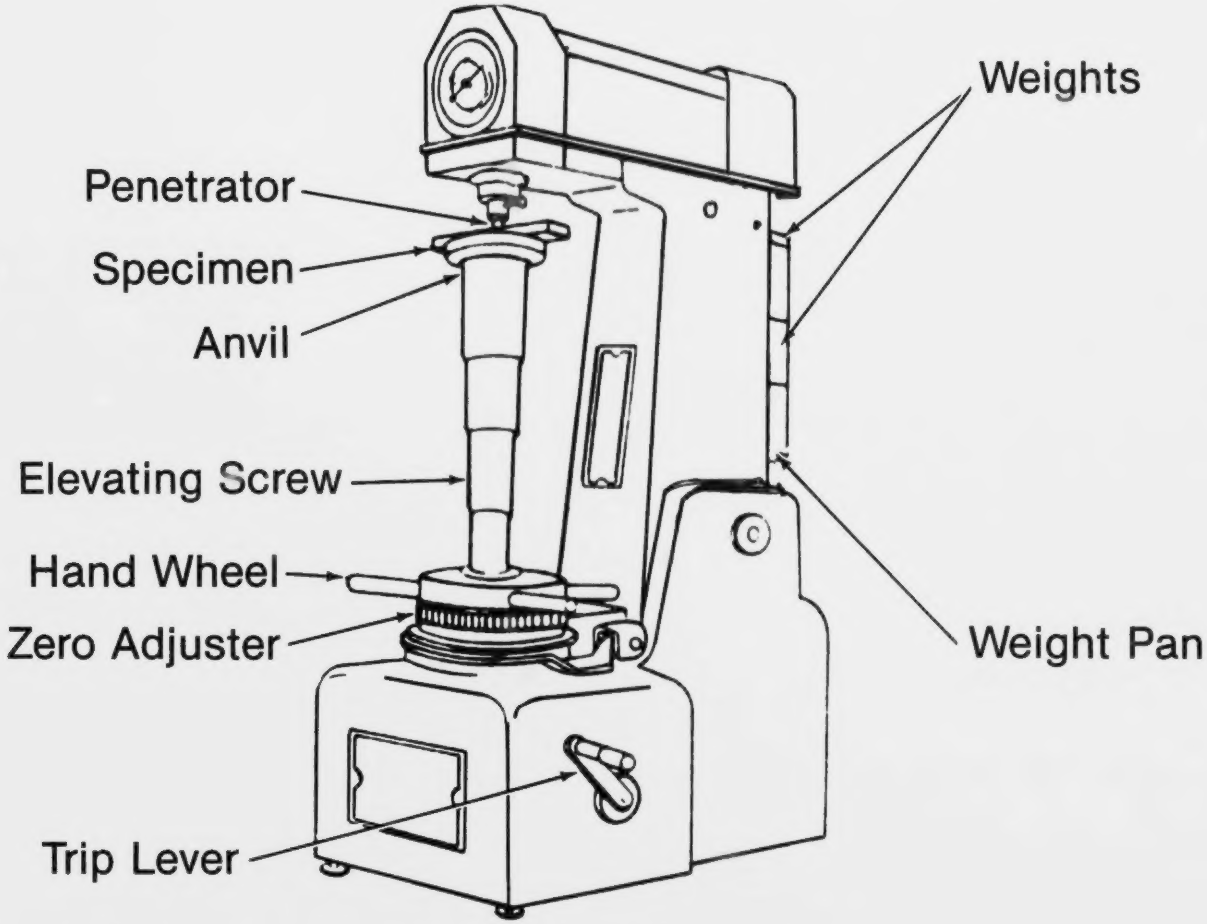

Crayon


Liquid


Pellets

Tempering Indicators

Rockwell Hardness Tester


Weights
Penetrator
Specimen
Anvil
Elevating Screw
Hand Wheel
Zero Adjuster
Trip Lever
Weight Pan

G102D-147

TM #15

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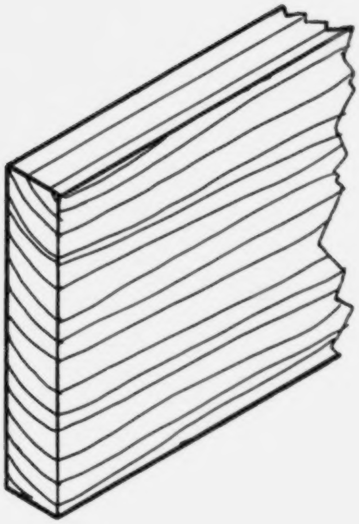
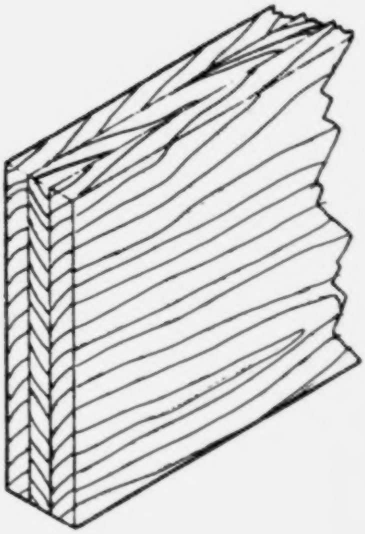
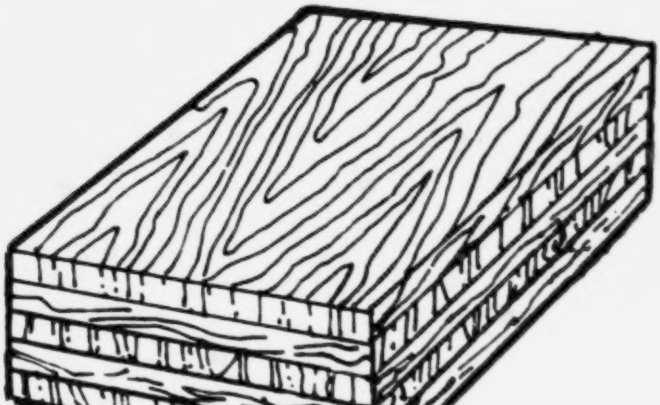
Types of Wood



A. Solid Wood



B. Laminated Wood



C. Plywood

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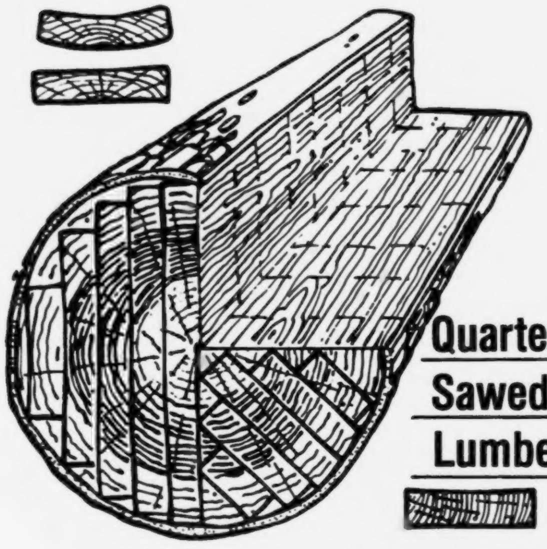
Methods of Sawing Lumber to Produce Solid Wood

Two Methods of Sawing Lumber


Plain Sawed Lumber
Not Widely Used
Quarter-Sawed Lumber
Most Common
"Less Warpage"

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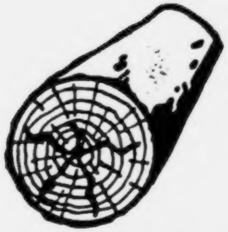
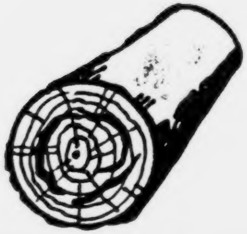
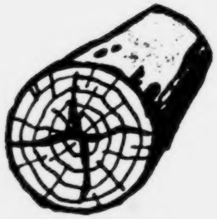
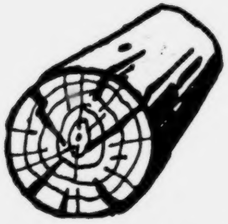
Wood Defects (Knots And Shakes)

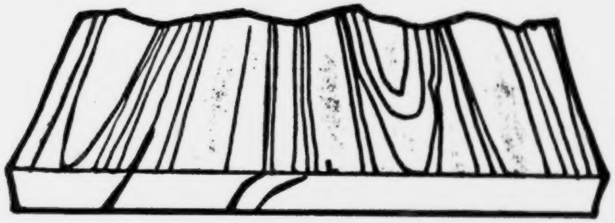
G102D-153

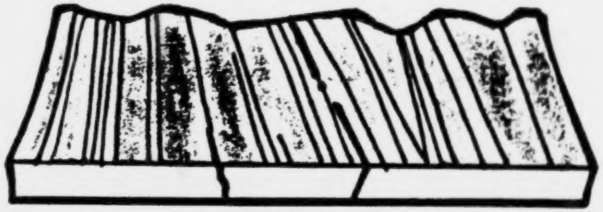

Heart Shake


Wind Shake


Star Shake


Checks and Splits


Shake


Splits and Shakes

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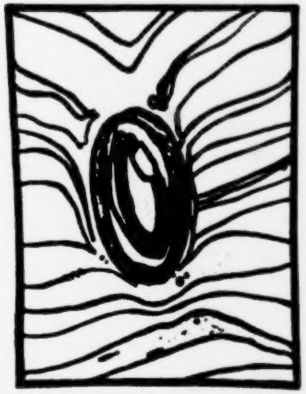
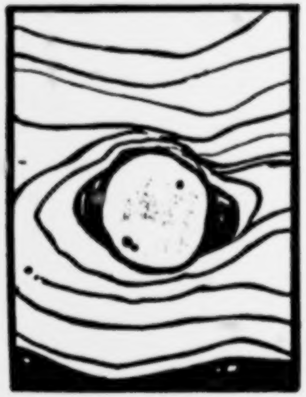
TM #18

Wood Defects (Knots And Shakes)

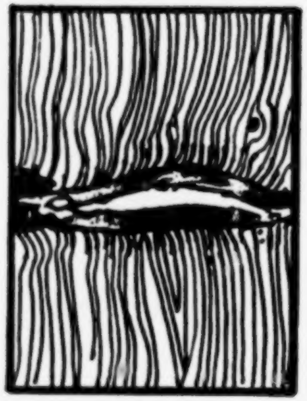
(Continued)



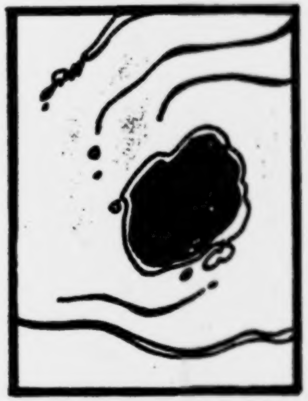
Intergrown



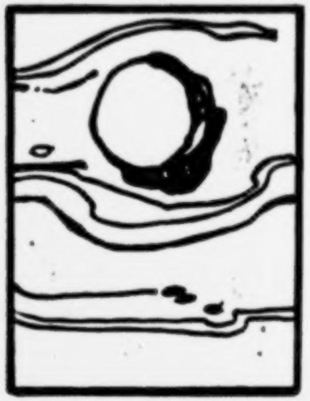
Encased



Spike



Decayed



Knot Hole

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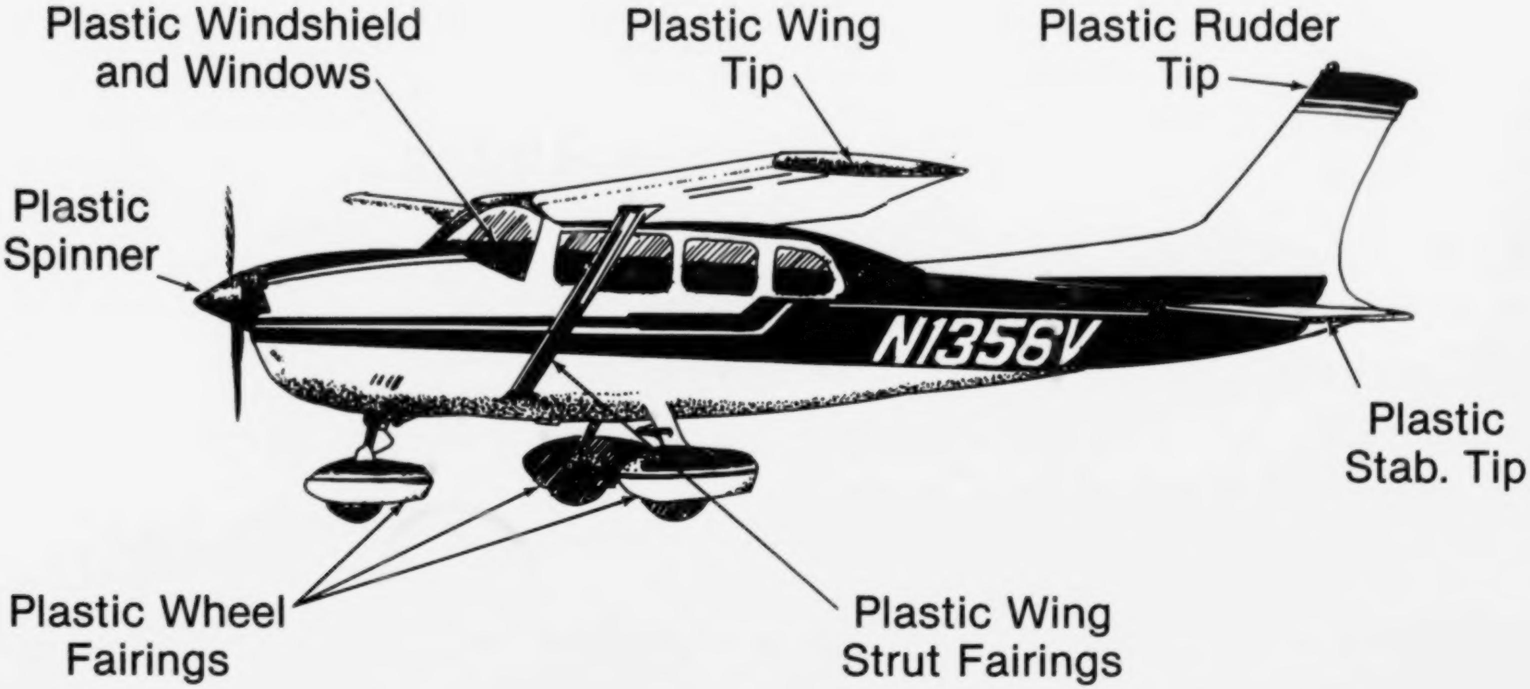
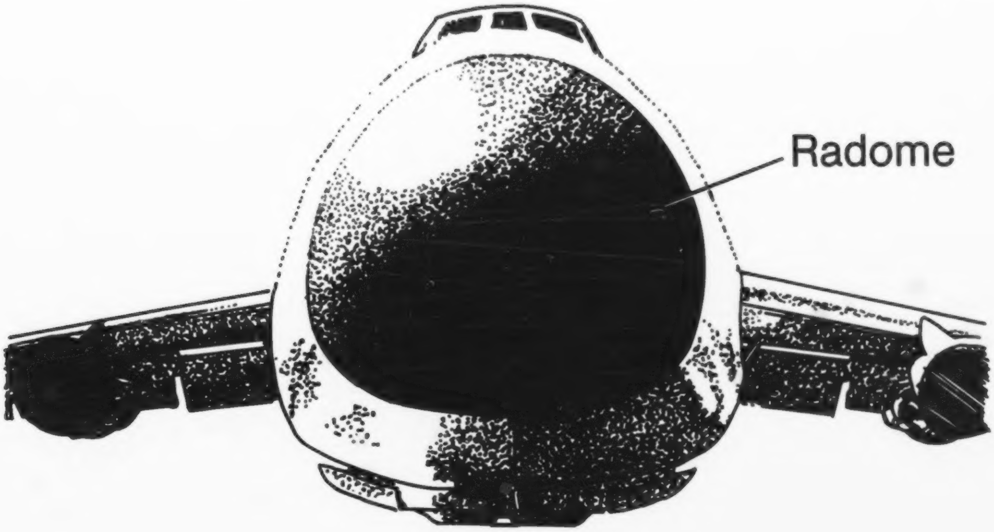
Use of Plastics in Aircraft Structures


Plastic Windshield and Windows
Plastic Wing Tip
Plastic Rudder Tip
Plastic Spinner
N1356V
Plastic Stab. Tip
Plastic Wheel Fairings
Plastic Wing Strut Fairings

Adapted with permission of Aviation Maintenance Publishers, Inc., Riverton, Wyoming.

Fiberglass Used For Radome Construction



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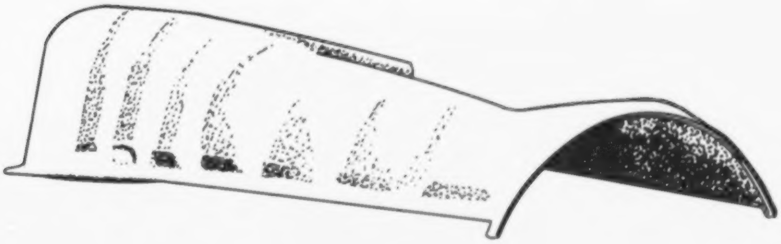
Modern Composite Structure



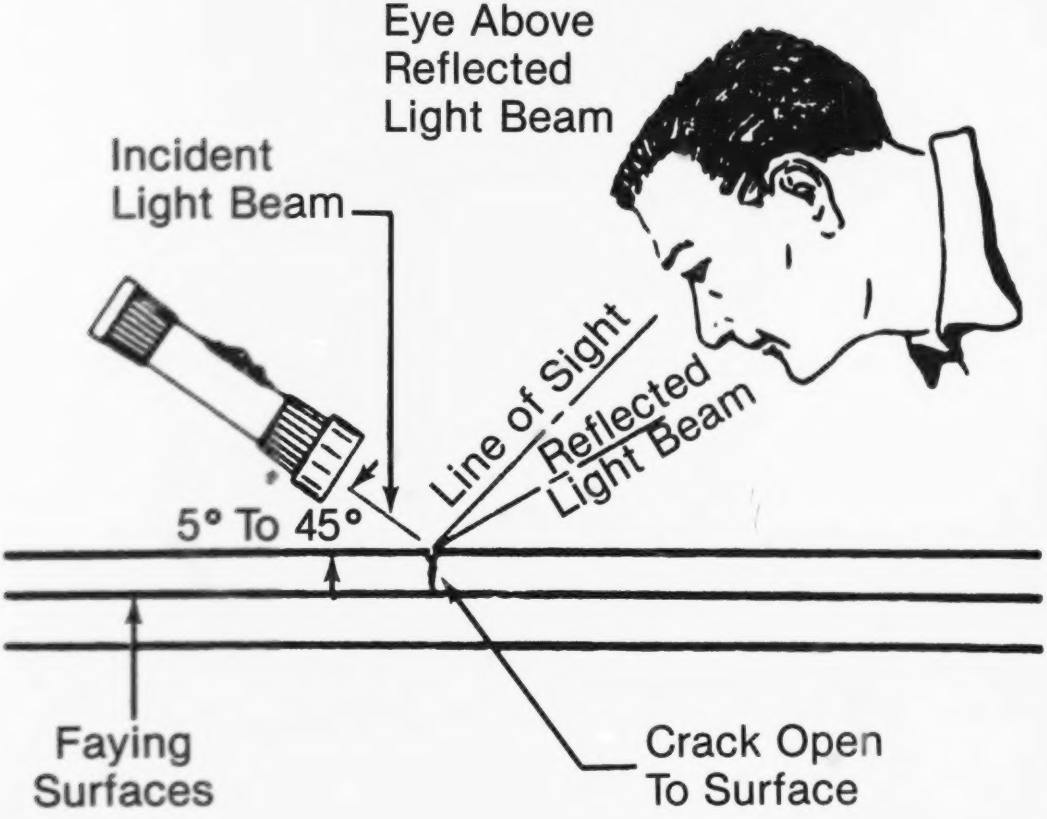
Structural Part of B-1 Bomber

Used with permission of Rockwell International.

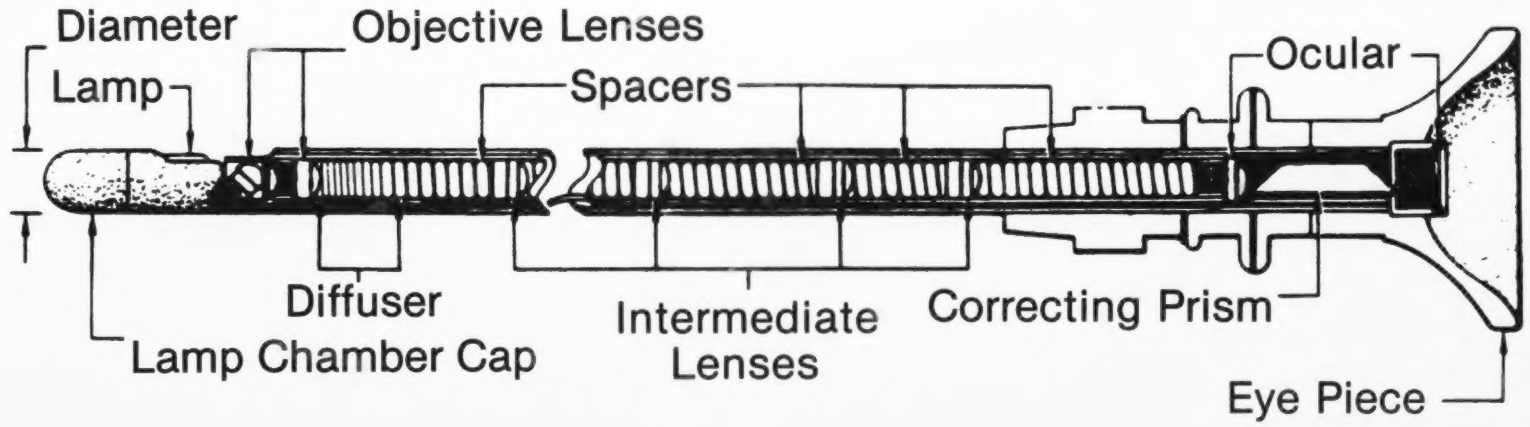
Types of Nondestructive Tests

1. Visual
2. Liquid Penetrant (Dye Penetrant)
3. Magnetic Particle
4. Eddy Current
5. Ultrasonic
6. Radiographic (X-ray or Isotope)

Visual Inspection

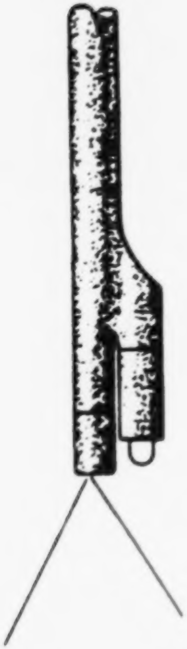

Eye Above Reflected Light Beam
Incident Light Beam
Line of Sight
Reflected Light Beam
5° To 45°
Faying Surfaces
Crack Open To Surface

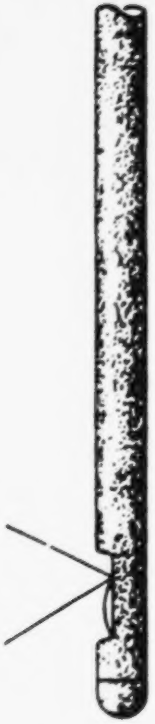
Borescopes

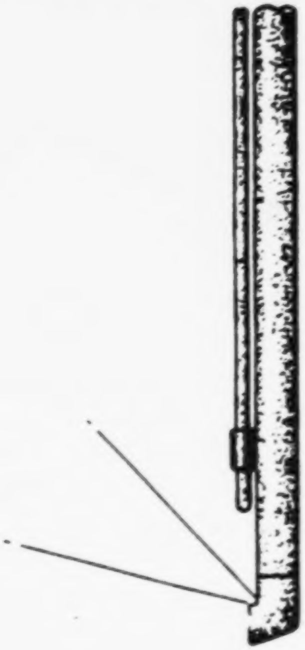

Diameter
Objective Lenses
Lamp
Spacers
Ocular
Diffuser
Lamp Chamber Cap
Intermediate Lenses
Correcting Prism
Eye Piece

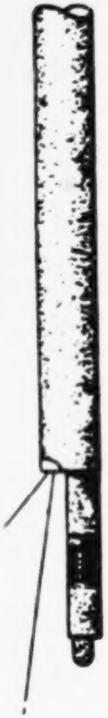
Construction of a Borescope (Rigid)

Borescopes
(Continued)
Types of Borescopes


Direct

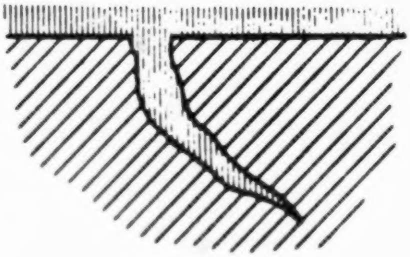

Right Angle


Retrospective

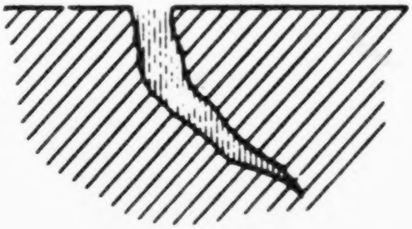

Foroblique

Liquid-Penetrant Inspection

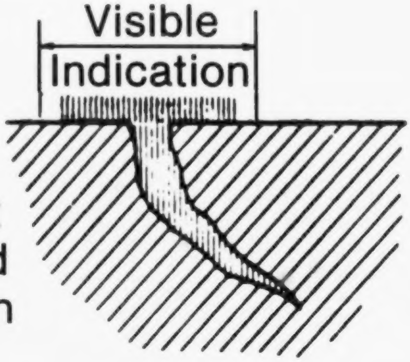
(A) Liquid Penetrant, Applied to Surface, Seeps Into Defect



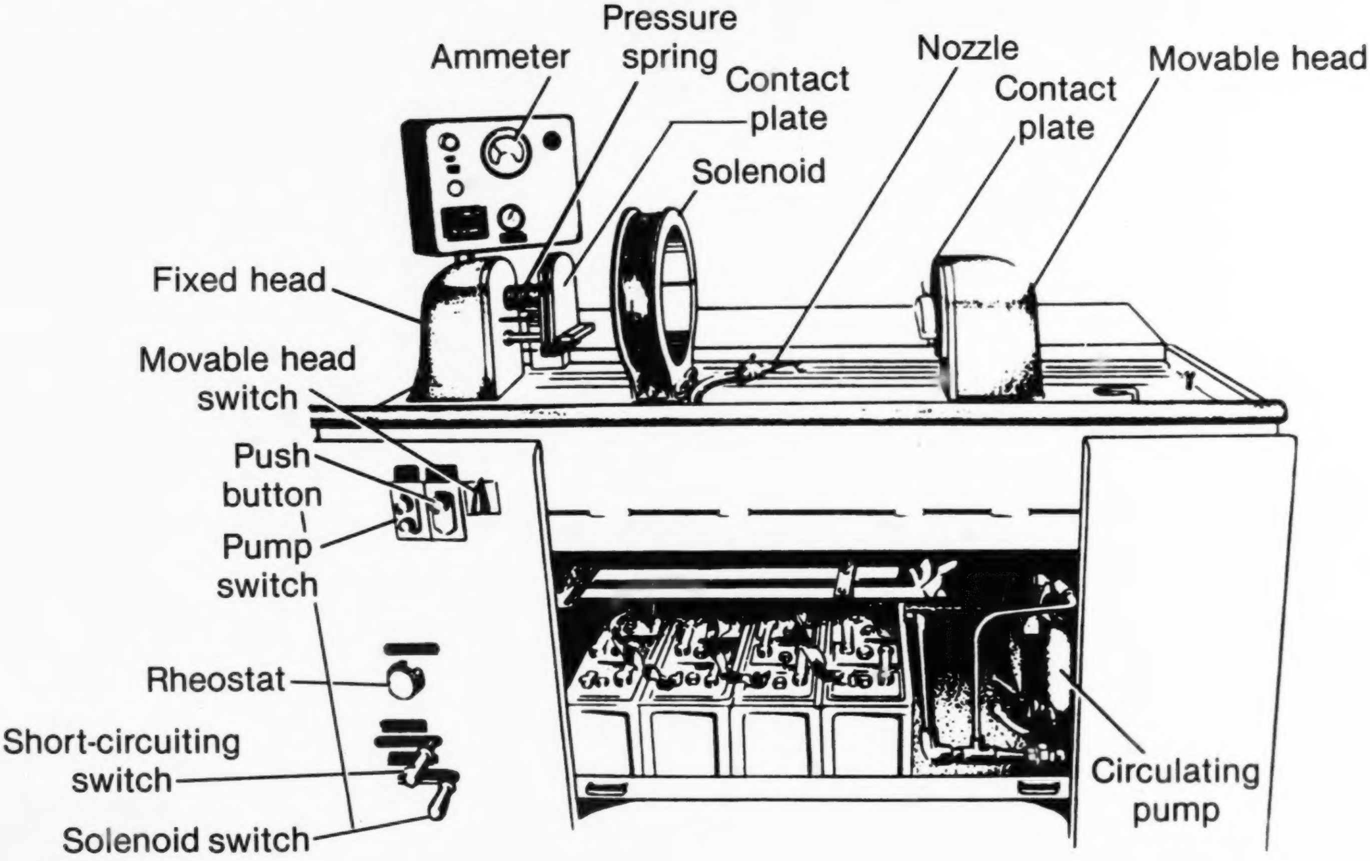
(B) Penetrant Removed From Surface, but Defect Remains Full



(C) Developer Acts as a Blotter to Draw Penetrant out of Surface Defect and Produce Visible Indication



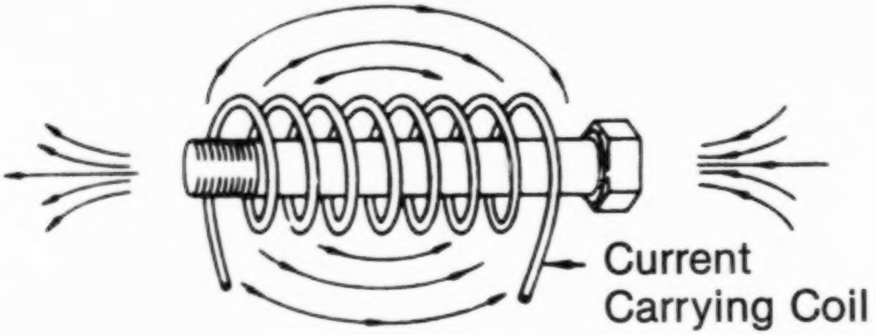
Fixed General Purpose Magnetizing Unit

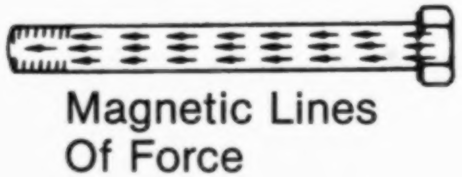

Pressure spring
Ammeter
Contact plate
Nozzle
Contact plate
Movable head
Solenoid
Fixed head
Movable head switch
Push button
Pump switch
Rheostat
Short-circuiting switch
Solenoid switch
Circulating pump

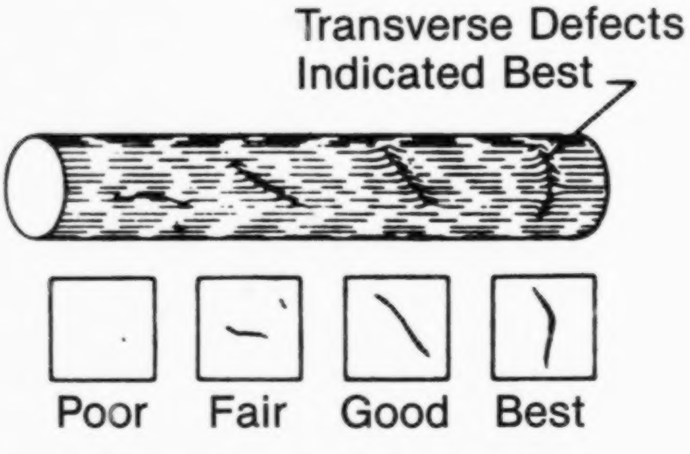
G102D-173

TM #28

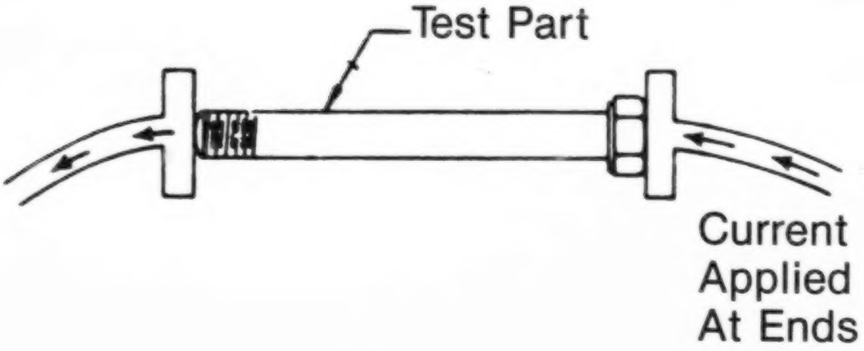
Longitudinal Magnetization

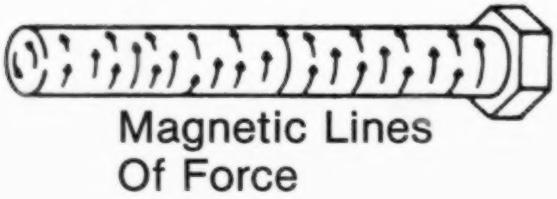

Current
Carrying Coil

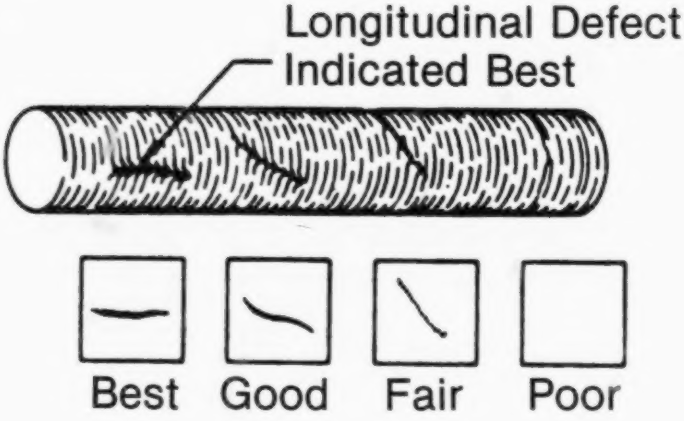

Magnetic Lines
Of Force


Transverse Defects
Indicated Best
Poor
Fair
Good
Best

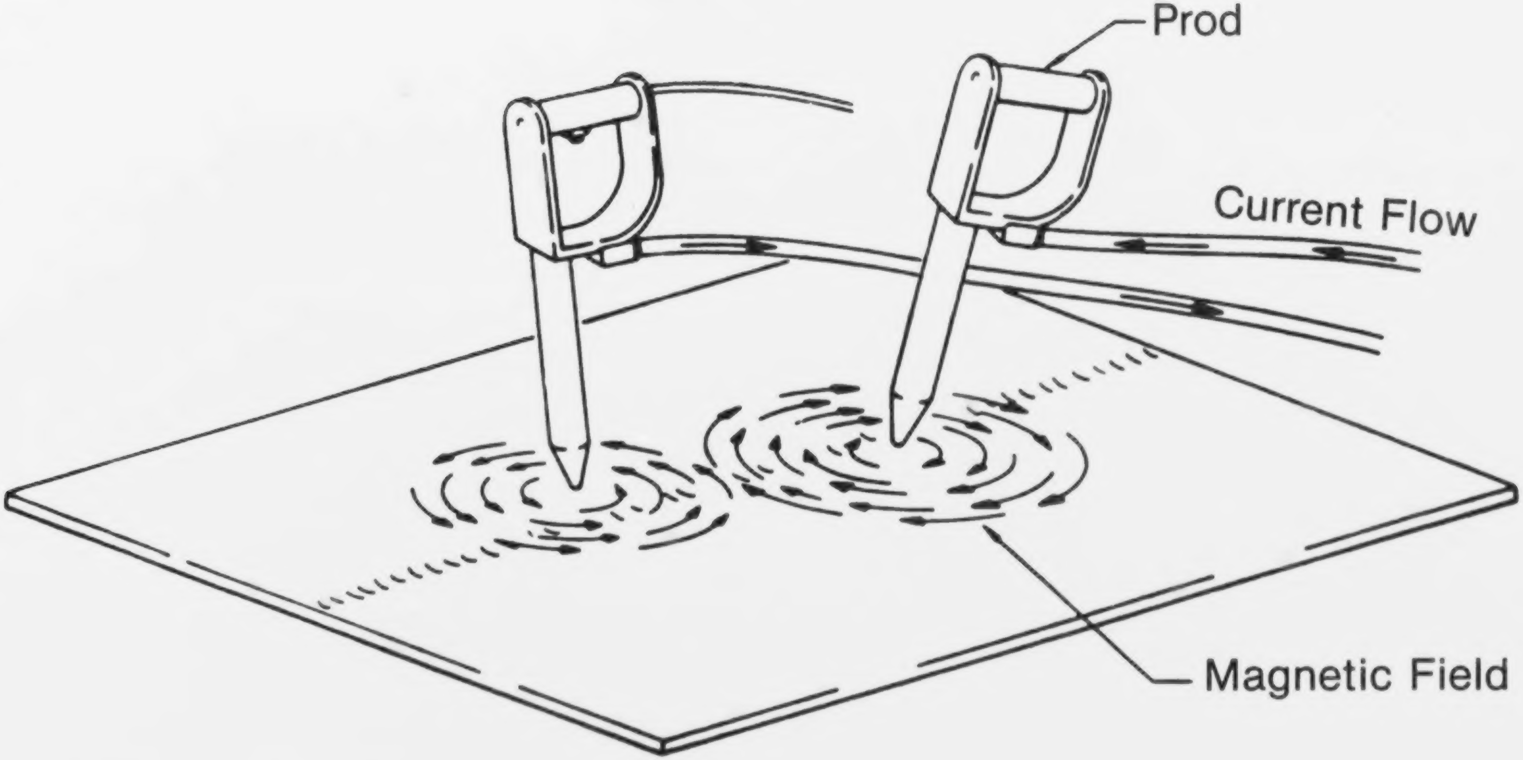
Circular Magnetization


Test Part
Current Applied At Ends


Magnetic Lines Of Force


Longitudinal Defect Indicated Best
Best
Good
Fair
Poor

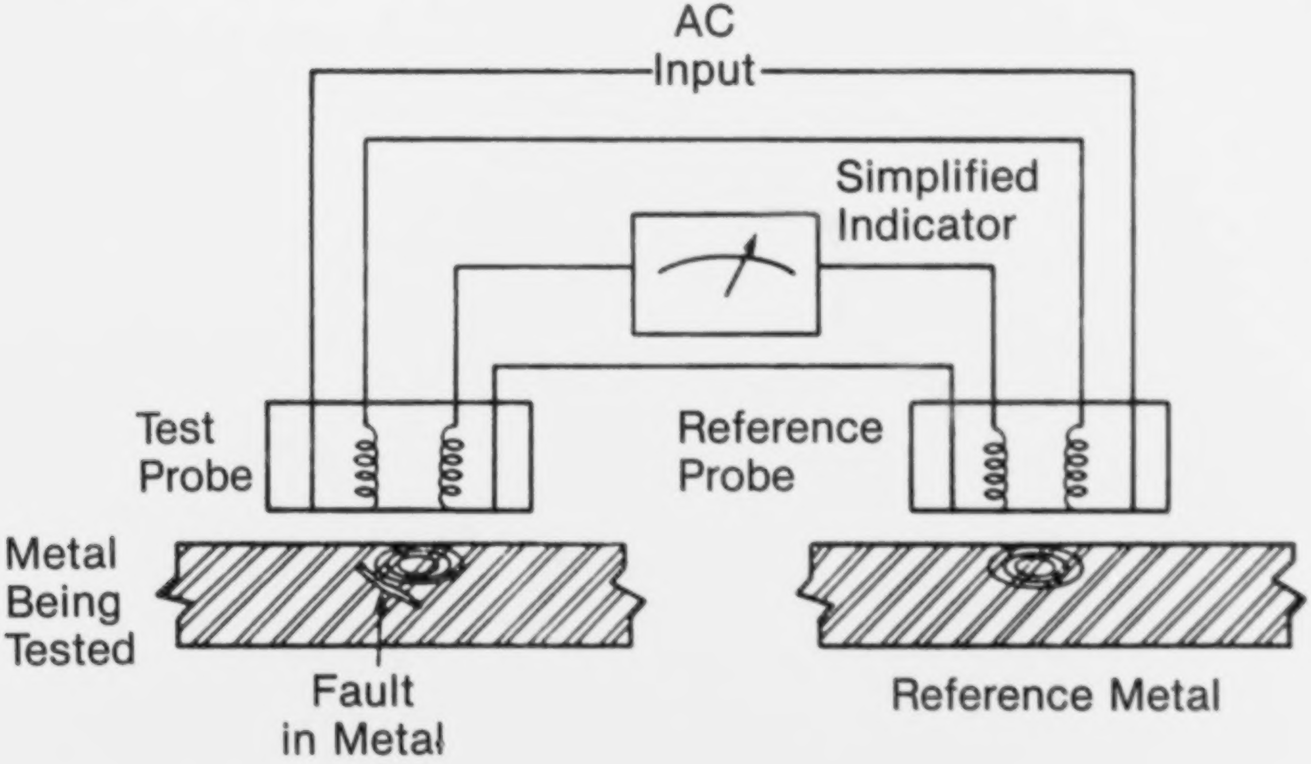
Prod Magnetization


Prod
Current Flow
Magnetic Field

G102D-179

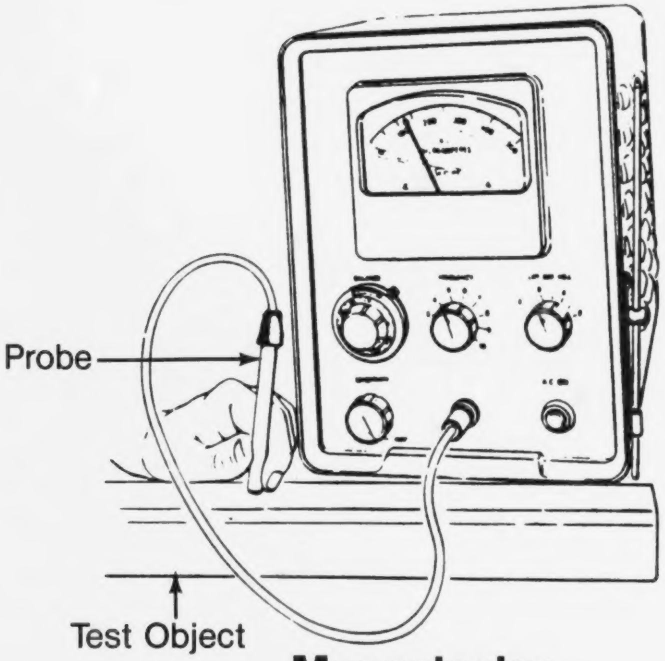
TM #31

Eddy Current Inspection

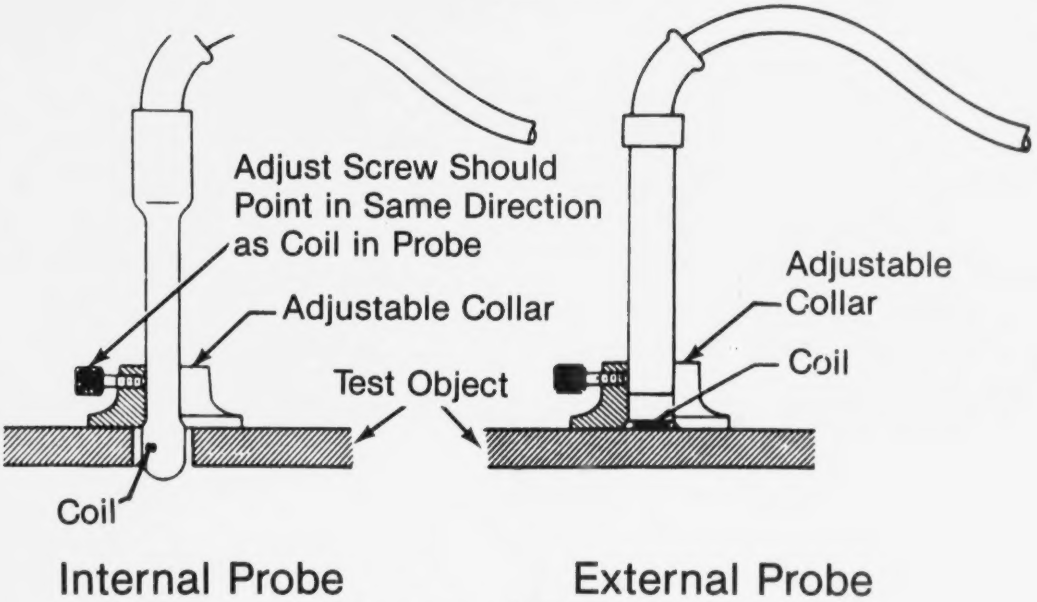

AC
Input
Simplified
Indicator
Test
Probe
Reference
Probe
Metal
Being
Tested
Fault
in Metal
Reference Metal

Eddy Current Inspection Comparison Test

Magnatester and Probes

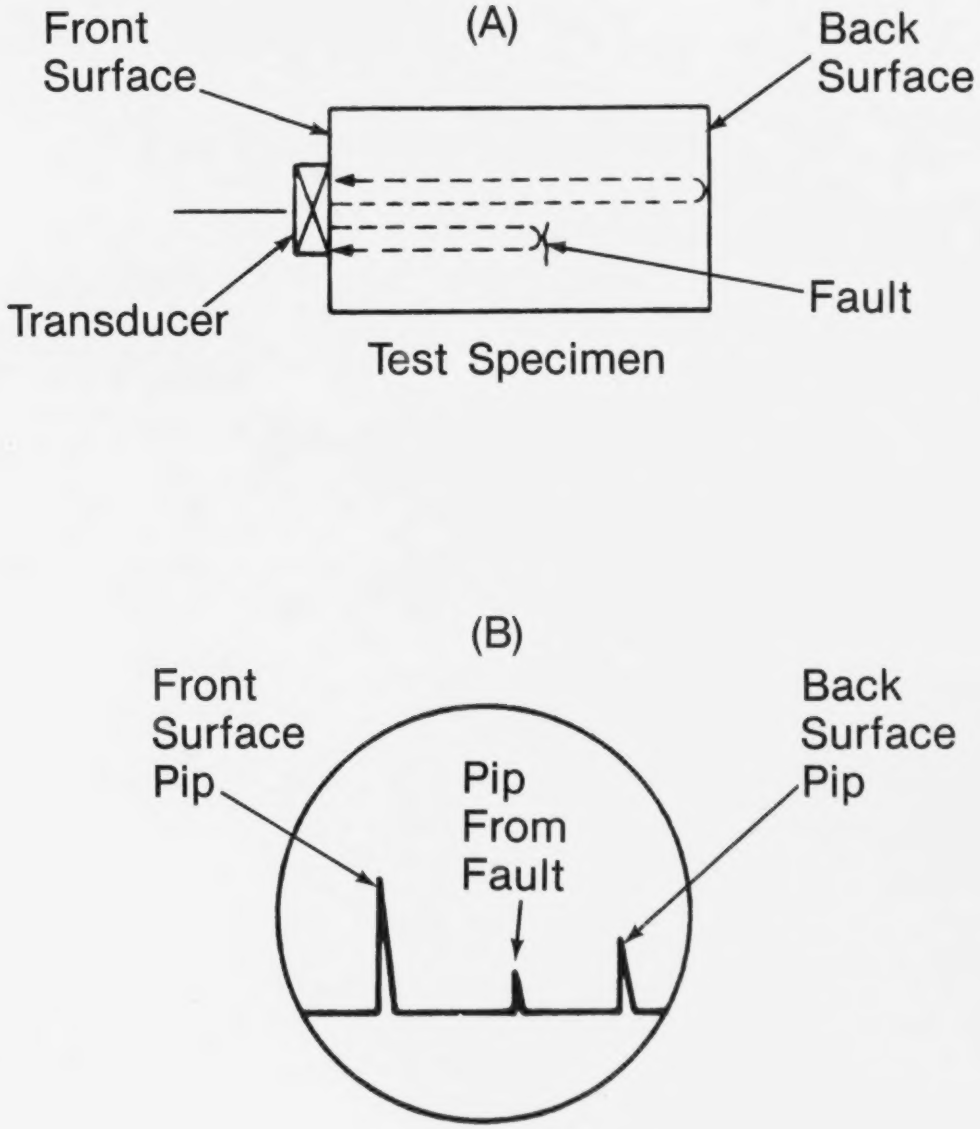

Probe
Test Object

Magnatester


Adjust Screw Should Point in Same Direction as Coil in Probe
Adjustable Collar
Test Object
Coil
Adjustable Collar
Coil
Internal Probe
External Probe

Types of Probes

Ultrasonic Inspection


(A)
Front Surface
Back Surface
Transducer
Fault
Test Specimen
(B)
Front Surface Pip
Back Surface Pip
Pip From Fault

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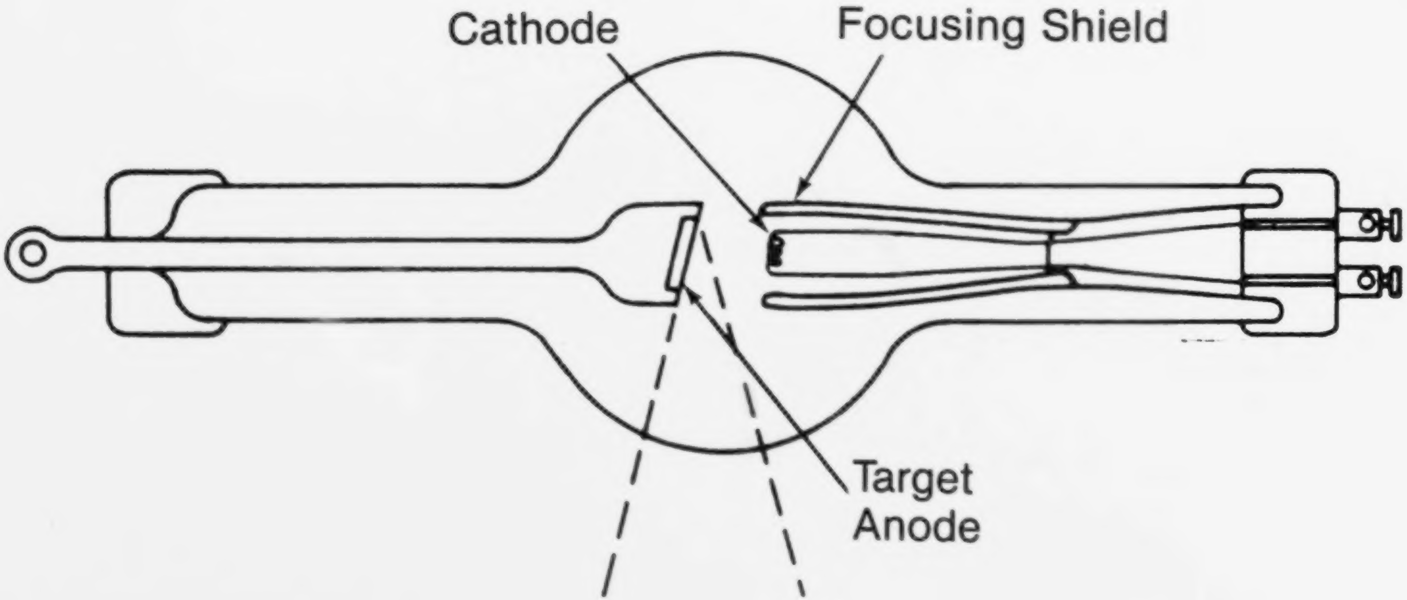
X-ray Tube


Cathode
Focusing Shield
Target
Anode

X-rays are produced when electrons from the cathode bombard the target anode and dislodge electrons.

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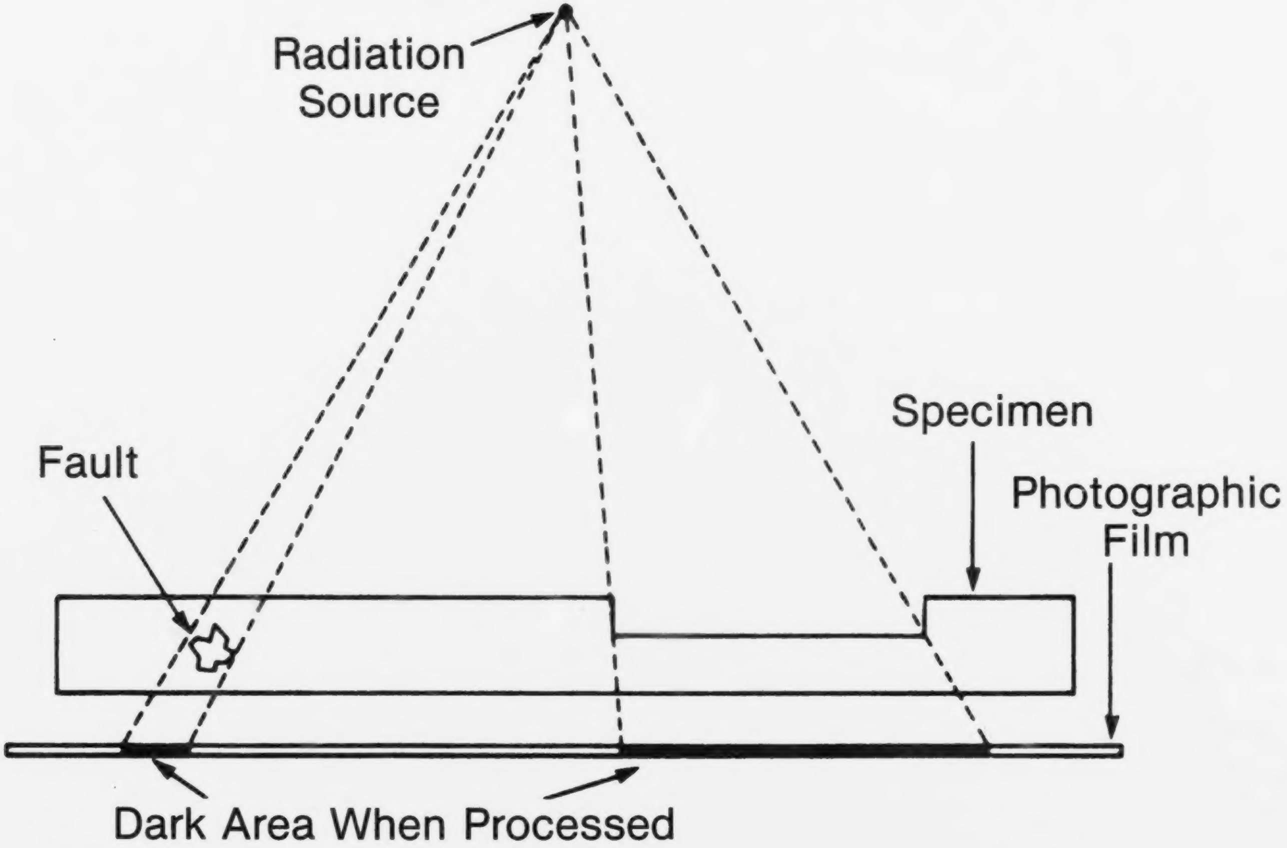
X-ray Radiation


Radiation Source
Specimen
Photographic Film
Fault
Dark Area When Processed

Radiation from X-rays or gamma rays penetrate a specimen and expose a photographic film. The denser the material, the less the exposure will be.

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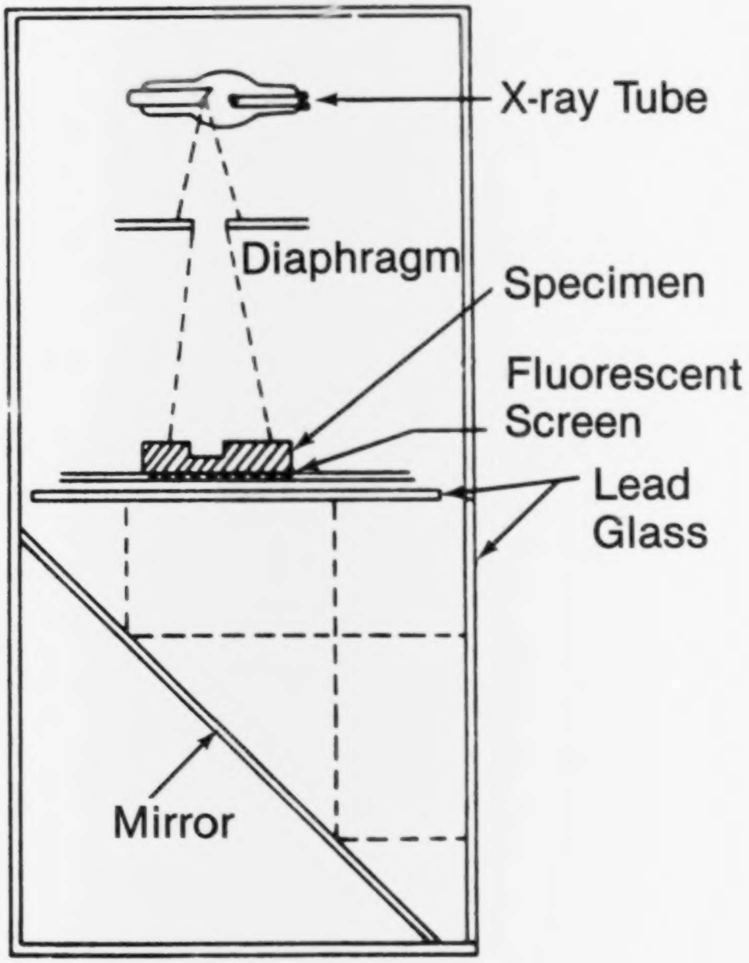
Fluoroscopy


X-ray Tube
Diaphragm
Specimen
Fluorescent Screen
Lead Glass
Mirror

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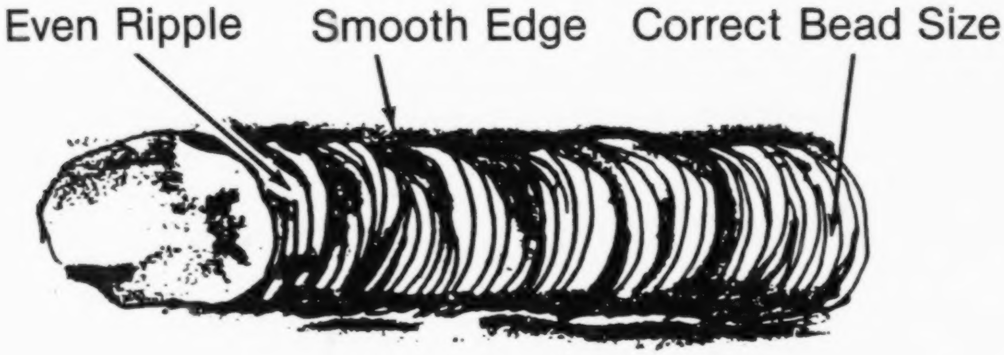
Example of a Good Weld


Even Ripple
Smooth Edge
Correct Bead Size

Clean, Bright Weld

Uniform in Width

Even, Well-Feathered Ripple

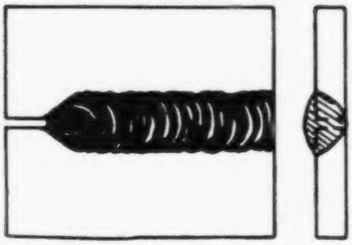
No Burn Marks Due to Overheating

Good Penetration

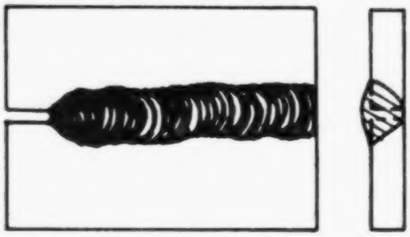
Free of Gas Pockets, Porosity, and Inclusions

Examples of Good and Poor Welds

Good Welds

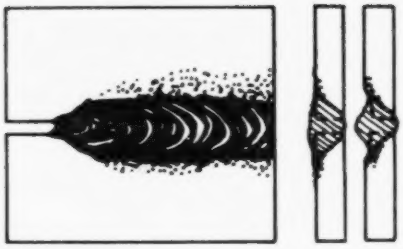


A

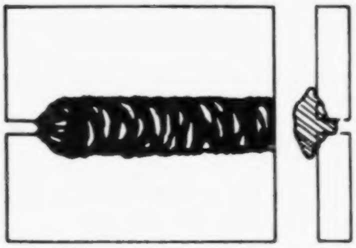


B

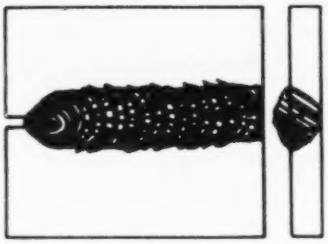
Poor Welds



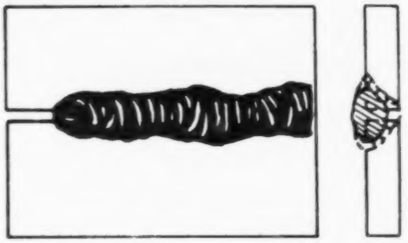
A



B



C



D

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

WORKBOOK SUPPLEMENT #1--State Facts Related to Heat Treatment Procedures for Steel

Although most manufactured types of steel appear similar in surface appearance, they are quite different in composition, strength, and hardness. The differences in strength and hardness are brought about by different kinds of heat treatment. The following questions are meant to help guide you in an examination of these heat treatment procedures and their results.

Answer the following questions using Figure 1-8 in EA-ITP-G, 6:I:14. Write the correct answers in the blanks.

A. Name the minimum temperature in degrees Fahrenheit required to anneal 4130.

____

B. When water is used for a quenching medium it shall not exceed ______ degrees Celsius.

C. What type of quenching medium is used on 1095? ________________

D. Explain what the letter "I" means in the hardening column for 30905.

____

____

E. What is the tensile strength for 4130 which was drawn at 700°F?

____

F. A tensile strength of 2,000,000 for NE8740 can be achieved using a temperature of ____________________ °F.

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

WORKBOOK SUPPLEMENT #2--Identify Advantages and Disadvantages of Various Inspection Methods

Due to the different types of equipment available and the area to be inspected, there are different methods of inspection. These methods are called nondestructive testing (NDT). The aviation maintenance technician must select the correct method of inspection according to several factors: accessibility, portability, type of defect sought, part material, and degree of sensitivity required.

Match the advantages and disadvantages of the various methods of inspection listed below to their correct descriptions on the following page. Write the correct numbers in the blanks.

1. Visual
2. Radiographic X-ray
3. Radiographic isotopes
4. Eddy current
5. Ultrasonic
6. Liquid penetrant
7. Magnetic particle

WORKBOOK SUPPLEMENT #2

	Advantages	Disadvantages
____A.	1. Semiportable. 2. Sensitive to small indications. 3. Detects surface and near-surface defects 4. Sensitive to inclusions as well as cracks. 5. Moderate skill required to perform.	1. Only suitable for ferro-magnetic material. 2. Part must be physically and visually accessible to perform test. 3. Removal of most surface coatings and sealant required. 4. Inspection is semidirectional requiring a general orientation of field to defect. 5. No permanent test results unless the indications from dry powder technique are recorded by pressing Scotch tape on the surface. 6. Not usable in areas where a strong magnetic field may damage instruments. 7. Part must be demagnetized after inspection.
____B.	1. Ability to inspect for both internal and surface defects. 2. Ability to inspect parts covered or hidden by other parts or structure. 3. Permanent test record obtained. 4. Minimum part preparation required.	1. Most expensive. 2. Airplane may have to be defueled. 3. Area must be cleared of other personnel to avoid X-ray exposure. 4. Test method is highly directional, depends on crack/X-ray source orientation. 5. High degree of skill required for varied technique development and radiographic interpretation.
____C.	1. Cheapness. 2. Portable. 3. High sensitivity. 4. Immediate results. 5. Minimum skill required to perform.	1. Can only inspect surface of parts accessible to penetrant application. 2. Defects must be open to surface. 3. Part preparation, such as removal of finishes and sealant required. 4. No permanent test results. 5. Direct visual detection of results required. 6. Requires a high degree of cleanliness for satisfactory inspection.

	Advantages	Disadvantages
____D.	1. Suitable for surface and subsurface defects. 2. Sensitive to small defects. 3. Immediate test results. 4. Little part preparation. 5. Wide range of material thicknesses can be inspected.	1. Surface of part to be inspected must be accessible to sonic probe. 2. Rough surfaces interfere with test results. 3. No permanent test record. 4. Test method is directional depending on sound beam-defect orientation. 5. High degree of skill and experience required to set up and interpret results for varied test conditions.
____E.	1. Portable. 2. Moderate coat. 3. Immediate results. 4. Sensitive to small indication. 5. Little part preparation.	1. Essentially a surface inspection. 2. Surface to be inspected must be accessible to contact by the probe. 3. Rough surfaces interfere with test sensitivity. 4. Suitable for inspection of metals only. 5. No permanent test record. 6. Considerable skill and familiarity required in handling test equipment. 7. Time consuming to scan large areas.
____F.	1. Cheapness. 2. Portability. 3. Immediate results. 4. Minimum special skill. 5. Minimum part preparation.	1. Suitable only for surfaces which can be viewed. 2. Generally detects only larger defects. 3. Misinterpretation of cracks and scratches.
____G.	1. It is portable. 2. Needs less area to gain access for energy source. 3. Can accommodate thicker material sources. 4. Less expensive than X-ray.	1. Must conform to Atomic Energy Commission regulations for handling and use.

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G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
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ANSWERS TO WORKBOOK SUPPLEMENTS

Workbook Supplement #1

A. 1525°F

B. 18

C. Oil

D. Hardened by cold work only

E. 180,000

F. 850

Workbook Supplement #2

A. 7

B. 2

C. 6

D. 5

E. 4

F. 1

G. 3

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G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

PROJECT GUIDE #1--Perform Basic Heat-Treating

PURPOSE: To prepare the aviation maintenance technician to perform the heat treatment of ferrous and nonferrous metals. The hands-on processes, knowledge, and safety practices required to accomplish this task will all be utilized in this project.

REFERENCE MANUAL: AC 65-9A pages 205-216, 218-220

EQUIPMENT AND TOOLS NEEDED:

A. Furnace(s)

(NOTE: Use two if possible; but one can be used if time is not a factor.)

B. Tongs

C. Rockwell Hardness Tester

D. Face shield

E. Safety glasses

F. Apron (nonflammable)

G. Shoe coverings

H. Asbestos gloves

I. 2 quench tanks

SUPPLIES AND MATERIALS:

A. Two pieces of steel flat stock (commercial grade) (recommended size: 2"x2")

1. 2330 steel

2. 4130 steel

B. Two pieces of 2024 flat stock (recommended size: 2"x2")

(2024-0-) - 0.032

(NOTE: These sheets should not be clad.)

C. One piece of 7075 flat stock (recommended size: 2"x2")

(7075-0) - 0.032

(NOTE: This sheet should not be clad.)

D. Oil for quench, with saybolt viscosity of 100 at 100°F (straight mineral oil)

E. Water for quench

PROCEDURE:

I. Heat Treatment and Tempering for Ferrous Metal

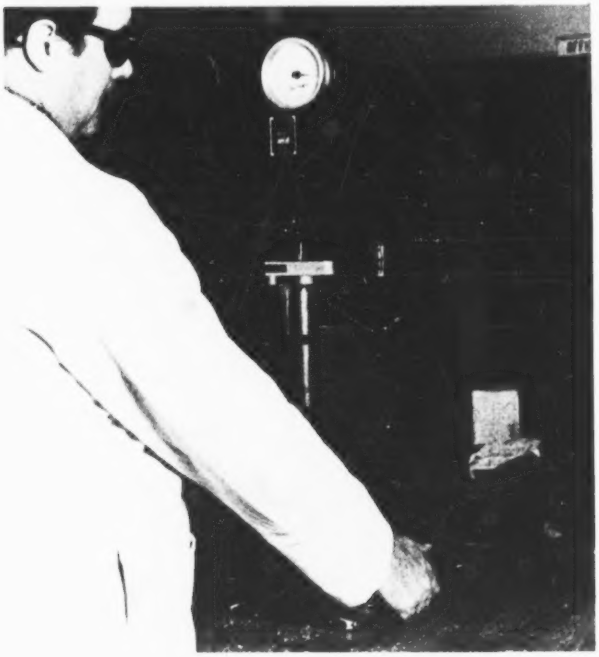
(NOTE: Be sure to thoroughly review the AC 65-9A text material for specifics of ferrous metal heat treatment and consult the furnace manufacturer's instructions before operation.)

A. Oil Hardening (general instructions)

1. Put on protective clothing as needed

2. Check hardness of specimen on the Rockwell Hardness Tester C Scale (Figure 1)

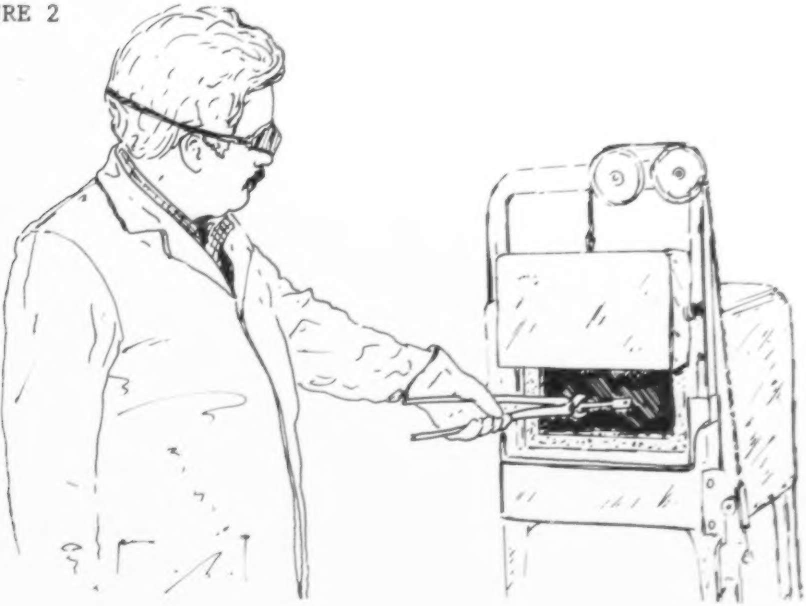
FIGURE 1



3. Heat furnace to a uniform temperature of 1500°F

4. Place oil-hardening steel into the furnace with a pair of tongs (Figure 2)

FIGURE 2

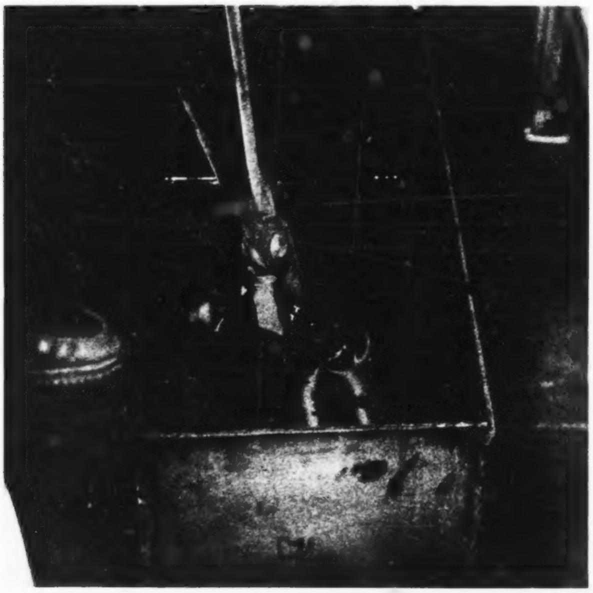


5. Allow heating of one hour per inch of cross-sectional area in order to achieve a uniform temperature throughout the material

6. Remove material from the furnace with the tongs and quench immediately in the oil medium (Figure 3)

   (NOTE: Immerse the part completely and agitate to allow even and complete cooling.)

FIGURE 3



(NOTE: It is best to have the oil at 120°F-140°F for best hardening results. Use regular heat-treat quenching oil.)

(CAUTION: Overheating the oil could result in combustion.)

7. Clean and check the specimen for hardness on the Rockwell Hardness Tester C Scale

8. Reduce furnace temperature to 800°F

9. Replace specimen in furnace and allow one hour of tempering time at the tempering temperature

10. Remove specimen from furnace with a pair of tongs and allow to cool in the air.

11. Recheck specimen on Rockwell C Scale after cooling

    (NOTE: There should be a noticeable decrease in the specimen hardness reading after tempering.)

B. Air hardening (general instructions)

1. Heat furnace to a uniform temperature of 1600-1700°F

   (NOTE: If furnace is not a controlled atmosphere furnace, a preheat of 1375°F is necessary before heating the specimen to 1700°F.)

2. Place specimen in the furnace with a pair of tongs

3. Allow heating of one hour per inch of cross-sectional area and until an even color is obtained

   (CAUTION: Do not heat longer than necessary to obtain desired temperature.)

4. Remove specimen from furnace with a pair of tongs

5. Allow to cool in still air

   (NOTE: Cooling rate may be increased by holding specimen in front of a forced air source.)

   EXAMPLES: Blower, fan

6. Check specimen on the Rockwell C Scale for hardness

7. Reheat furnace to a uniform temperature of 700°F

8. Put specimen back into furnace with a pair of tongs

9. Allow two hours for specimen to soak at this temperature

   (NOTE: The time at temperature, referred to as soaking time, is measured from the time the coldest metal reaches the minimum limit of the desired temperature range.)

10. Remove specimen from furnace with a pair of tongs

11. Recheck specimen on the Rockwell C Scale for hardness

12. Record hardness reading from the specimen

C. Identify specimens and record all hardness readings

D. Have instructor rate your work

II. Heat Treatment for Nonferrous Metal (general instructions)

A. Solution Heat Treatment

(NOTE: Review AC 65-9A for specifics on nonferrous metal treatment and consult furnace manufacturer's instructions.)

1. Put on protective clothing as necessary

2. Heat furnace to a uniform temperature of 940°F

3. While furnace is heating, check hardness of 2040-0 specimen on Rockwell Hardness Tester B Scale.

4. Place specimen in furnace with a pair of tongs

5. Soak the metal for 30 minutes

   (NOTE: The time at temperature, referred to as soaking time, is measured from the time the coldest metal reaches the minimum limit of the desired temperature range.)

6. Remove specimen from furnace after soaking time has elasped and quench in water quench tank

   (NOTE: The temperature of the water before quenching should not exceed 85°F and a sufficient quantity of water should be used to keep the temperature rise under 20°F. When solution heat treating the elasped time between soaking and quenching should not exceed 10 seconds.)

7. Remove specimen from quench tank

8. Recheck the hardness of the specimen on the B Scale of the Rockwell Hardness Tester

B. Precipitation Heat Treatment

1. Check the hardness of the 7075-0 specimen on the Rockwell Hardness Tester B Scale; record hardness

2. Perform solution heat-treatment to the 7075-0 specimen

3. Check the hardness of the specimen; record results

4. Reduce furnace temperature to 250°F

5. Place specimen in furnace, using the tongs

6. Allow specimen to remain at this temperature for 24 hours

   (NOTE: Monitor furnace periodically to control temperature and ensure that the furnace presents no fire danger from being at this temperature for this extended period of time.)

7. Remove specimen from the furnace with tongs and allow to air cool

8. Check hardness of specimen; record results

C. Identify specimens and record all hardness readings

D. Have instructor evaluate your work

E. Return equipment and materials to instructor

PROJECT GUIDE #2--Perform a Foam Core/Glass Fiber Lay-up or Simple Fiberglass Repair

PURPOSE: To prepare you to construct assemblies using foam core/glass fiber lay-up techniques.

REFERENCE MATERIAL: Manufacturers' Safety Data Sheets

EQUIPMENT AND TOOLS NEEDED:

A. Utility knife

B. Shears (Wiss quality recommended)

C. Rib template

D. Bandsaw

E. Workbench

F. Hole saw

G. 4" plastic body filler applicators

H. Safety glasses

I. Dust mask

J. Nonexplosive can

K. Protective gloves

SUPPLIES AND MATERIALS:

A. Clark brand polyurethane foam - 1/4" x 8" x 24"

B. 2 pieces of plain weave 6-ounce glass fiber cloth

C. Approximately one pint of vinyl ester resin

D. Methyl-ethyl-ketone-peroxide catalyst (MEKP)

E. Thixotropic agent (Aeroseal or Microballoons recommended)

F. Methyl-ethly-ketone (MEK) sufficient amount for clean-up

G. Plastic table covering

H. One-pint paper mixing cups

I. Wooden stir sticks

J. 2" disposable natural bristle brush

K. Soft lead pencil

(CAUTION: Wear safety glasses and dust mask at all times. Under no circumstances use any of the solvents to clean hands or other parts of the body.)

PROCEDURE:

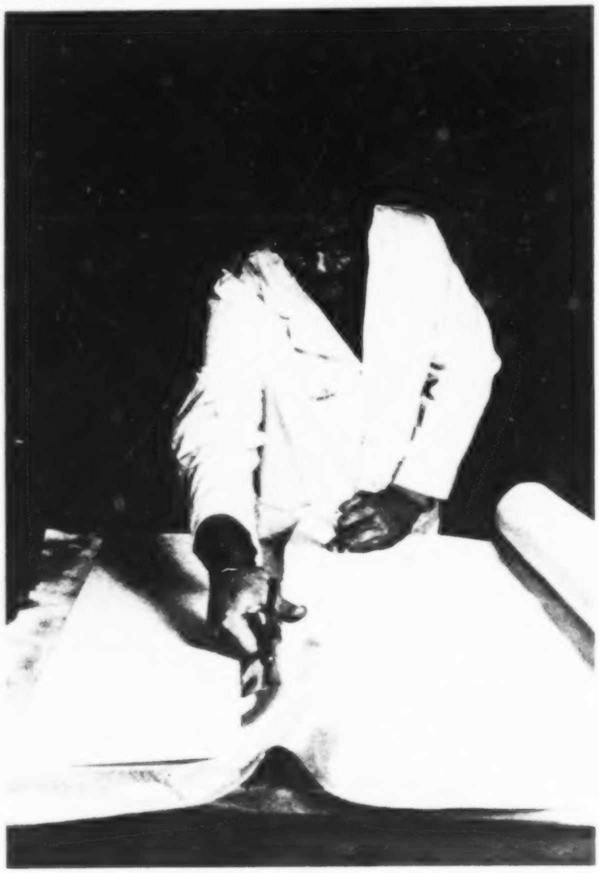
A. Cover workbench with plastic

(NOTE: Good housekeeping is of vital importance to the success of the project.)

B. Cut the 1/4" x 8" x 24" foam core from the shop supply using the utility knife

C. Cut 2 pieces of glass fiber cloth 10" x 26" from the shop supply using the shears (Figure 4)

FIGURE 4

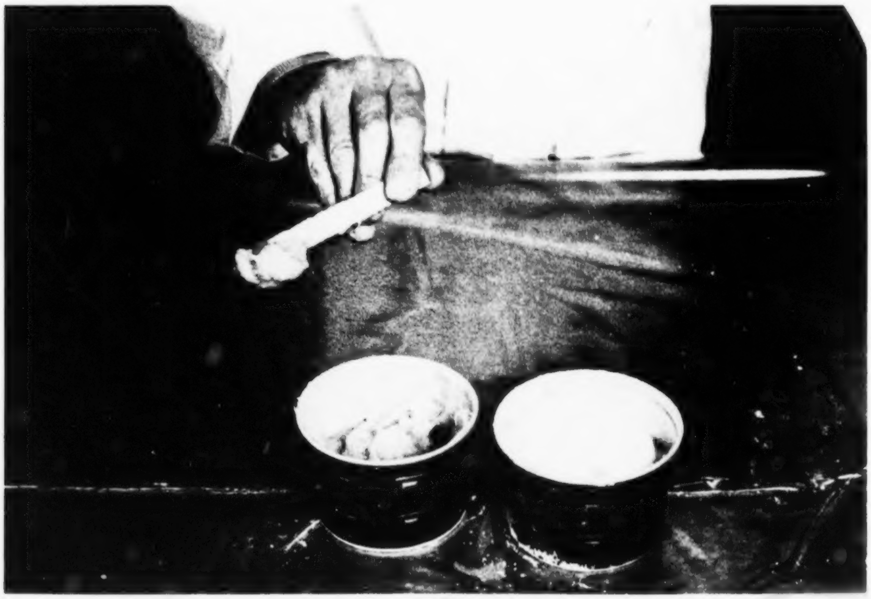


D. Mix thixotropic agent with resin, using the mixing cups and wooden stir sticks (Figure 5)

(CAUTION: Segregate cleaning materials from adhesives during curing process.)

(NOTE: This paste will be used to seal the foam core. The consistency of the paste should be such that when an amount the size of a golf ball is picked up and held on the stir stick above the mixing cup, the paste does not flow easily off the stick.)

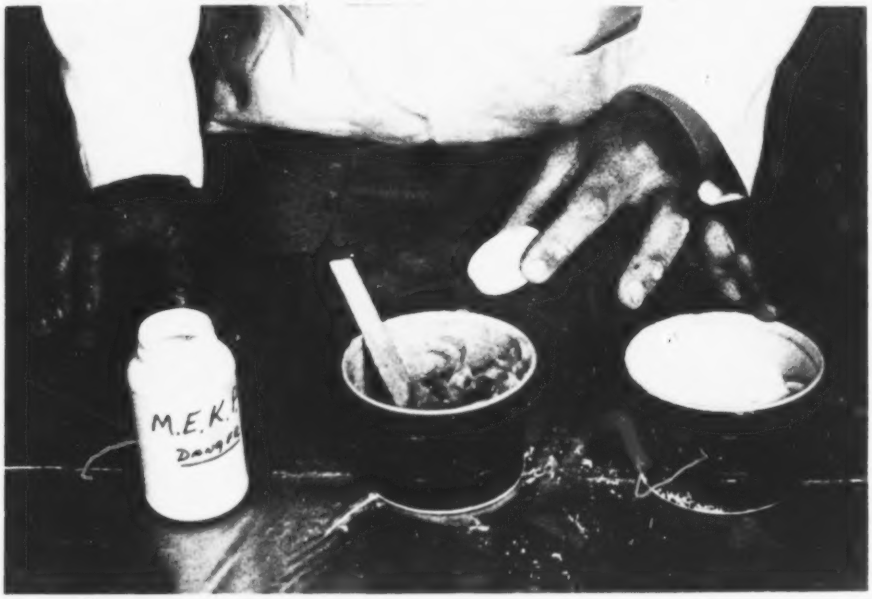
FIGURE 5



E. Add the catalyst according to manufacturer's recommendations (Figure 6)

(NOTE: More catalyst can be used on cool days when the temperature is under 68°F to shorten the curing time.)

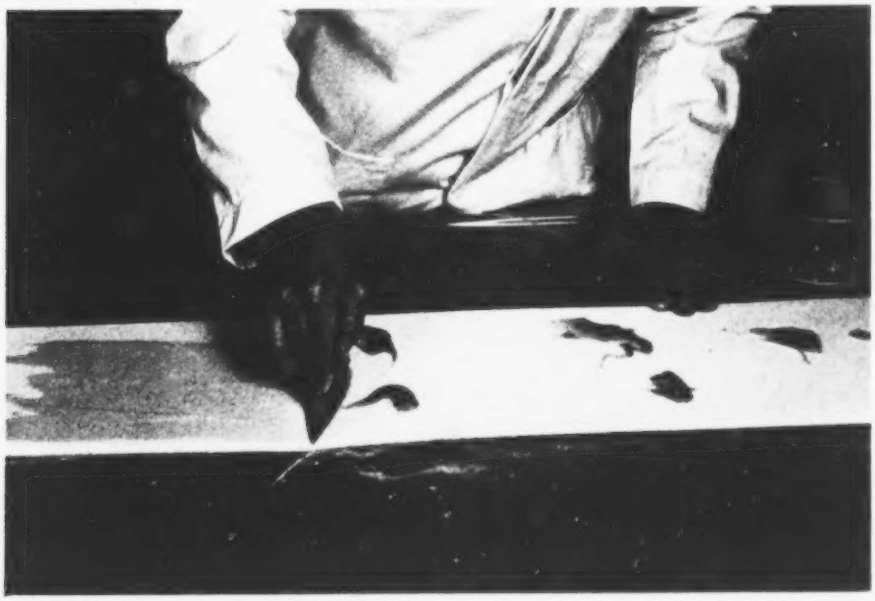
FIGURE 6



F. Seal the foam core with a thin coat of paste using the plastic body filler applicators (Figure 7)

(NOTE: The thickness of the paste which is applied to the foam core will be approximately the thickness of a business card.)

FIGURE 7

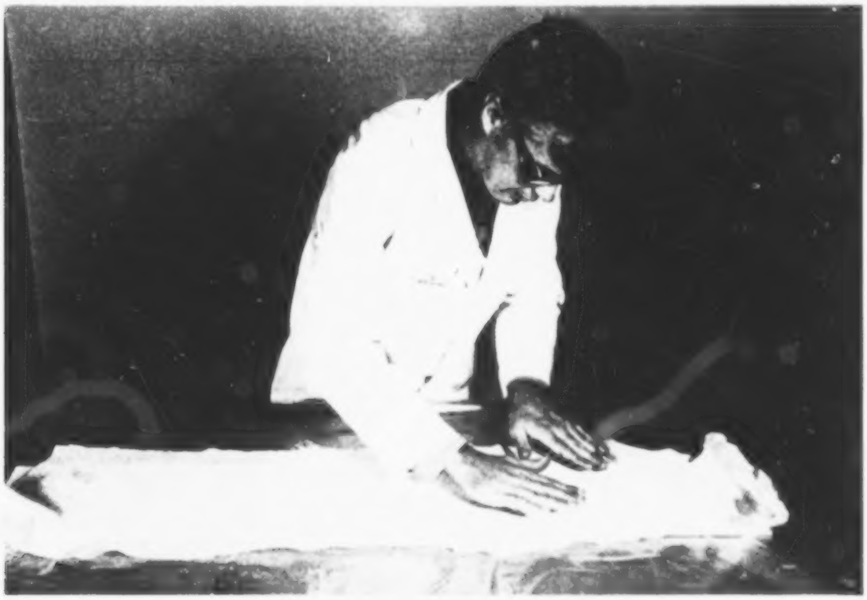


G. Allow paste to cure completely before continuing

H. Perform procedures D through G for the opposite side of the foam core

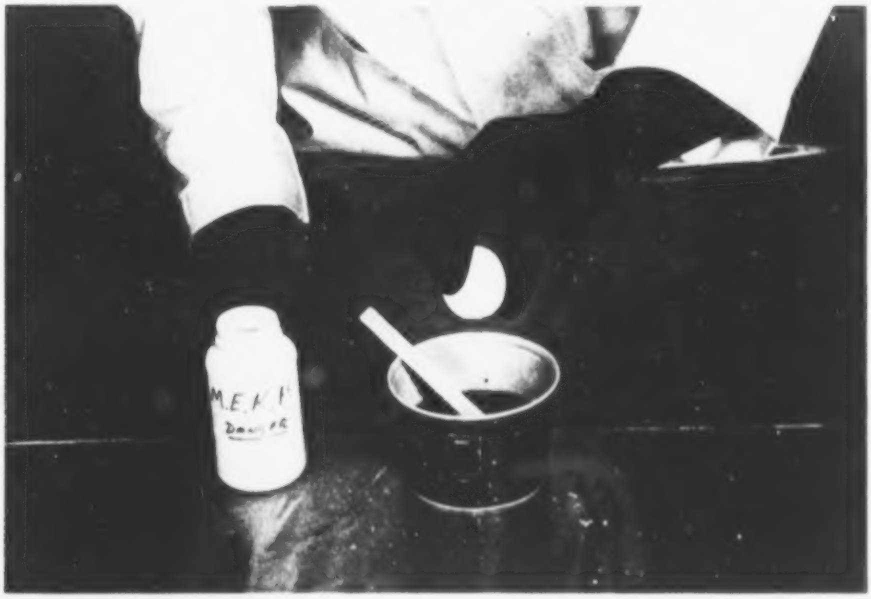
I. Lay pre-cut glass fiber cloth on one side of the foam core (Figure 8)

FIGURE 8



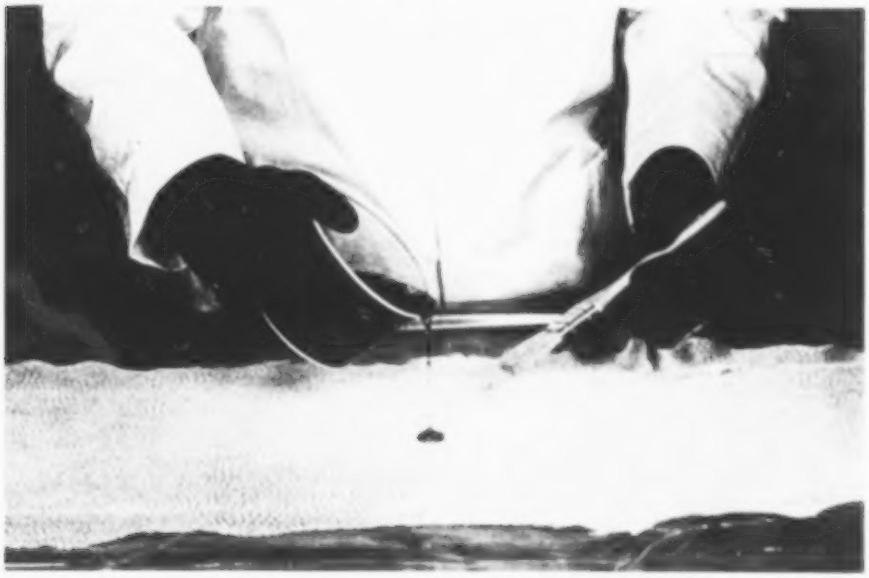
J. Mix approximately two ounces of resin with the catalyst according to manufacturer's recommendations (Figure 9)

FIGURE 9



K. Pour a small amount of resin (approximately one-half of the mixed volume) on the center of the glass fiber cloth-covered foam core (Figure 10)

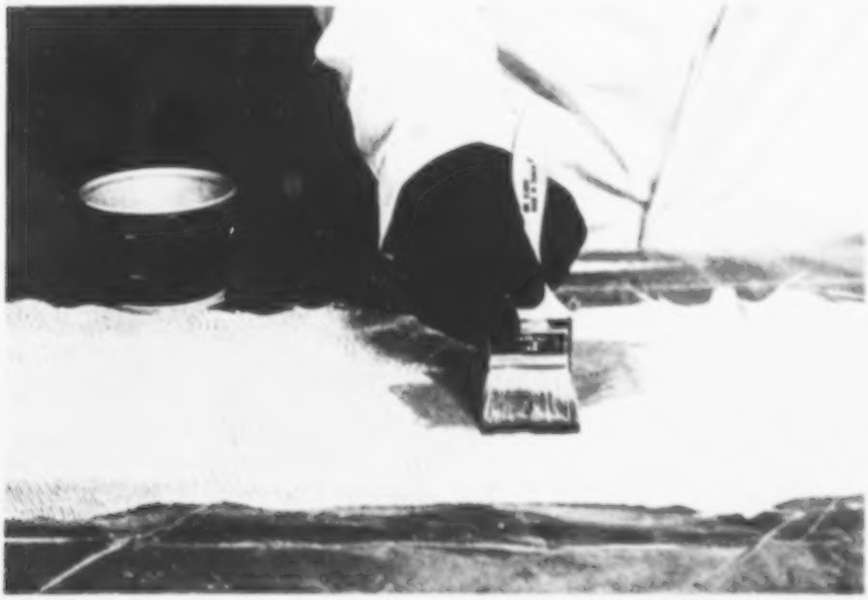
FIGURE 10



L. **Using the bristle brush, spread resin over the cloth, using a stippling method (Figure 11)**

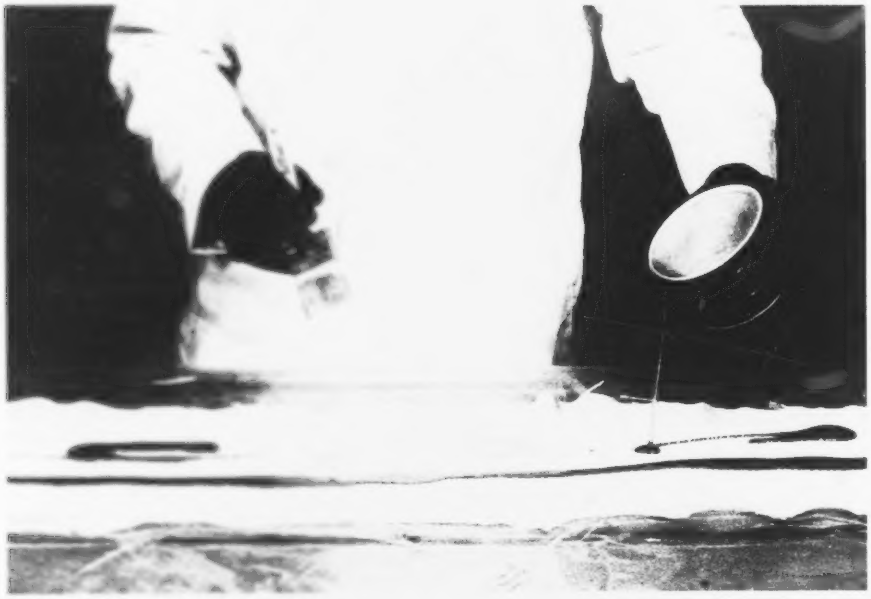
(NOTE: Stippling is accomplished by a combination of daubing and spreading actions. When not in use, place paintbrush in small cup of MEK.)

FIGURE 11



M. Use the remaining resin as needed to fully wet the glass fiber cloth (Figure 12)

FIGURE 12

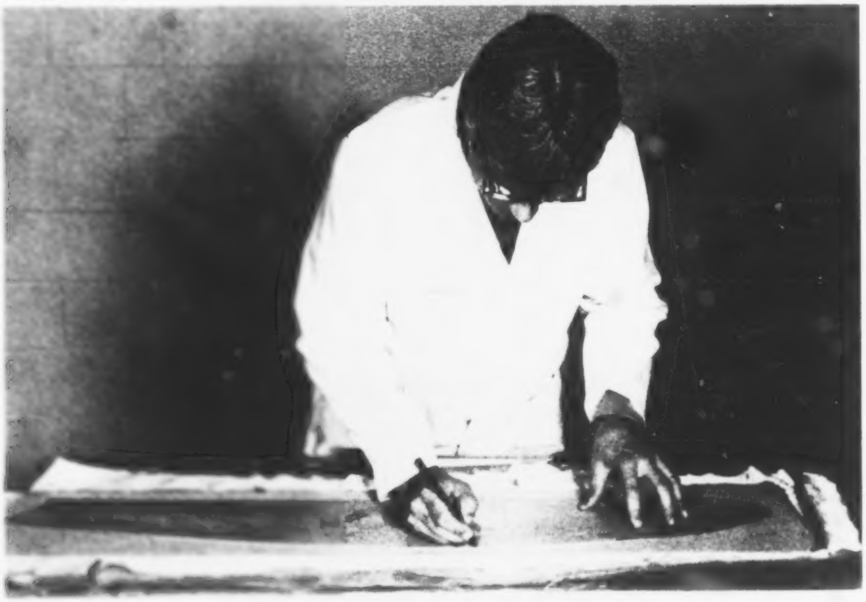


N. Allow to cure completely before continuing

O. Repeat procedures I through N for the opposite side

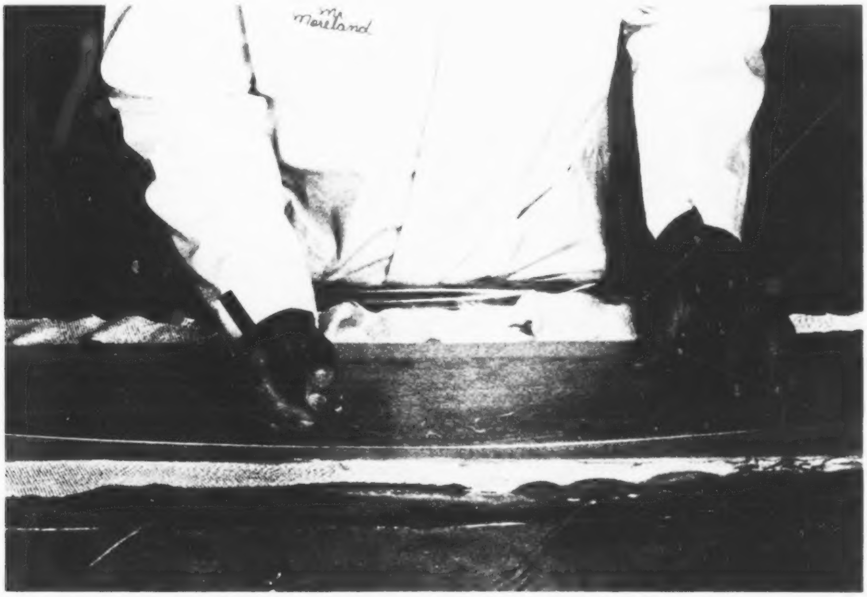
P. Place rib template over the completed lay-up (Figure 13)

FIGURE 13



Q. Use the soft lead pencil to trace the template outline onto the lay-up (Figure 14)

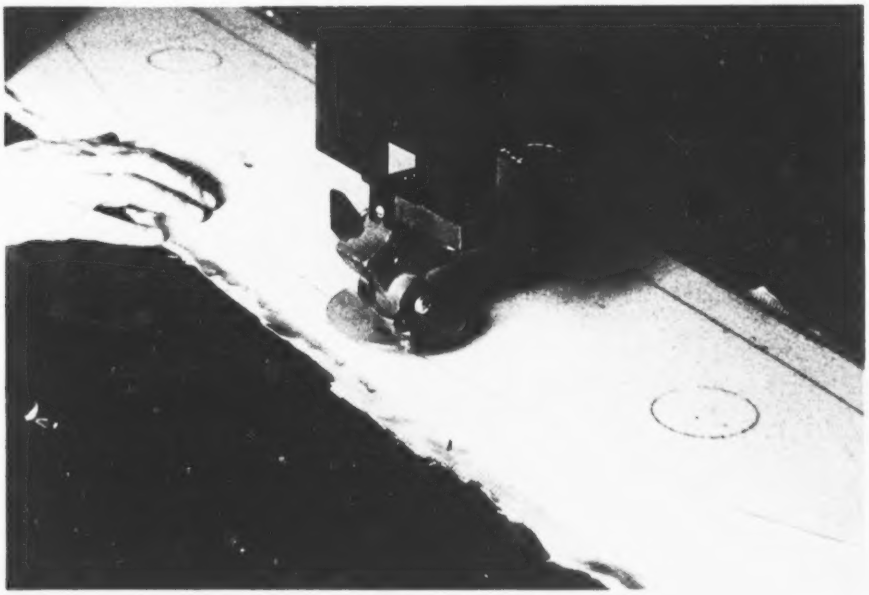
FIGURE 14



R. Cut inside the visible lines with the bandsaw; cut the perimeter of the rib area (Figure 15)

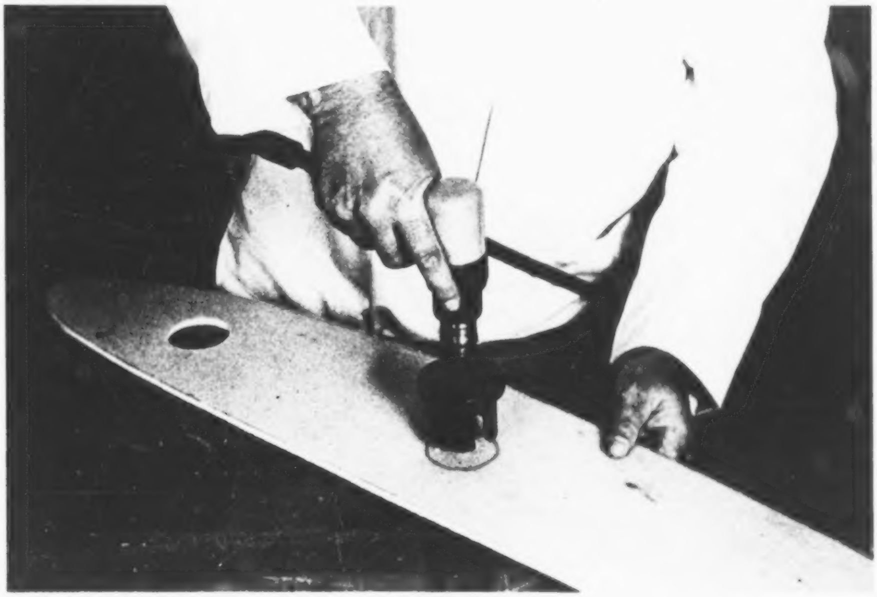
(CAUTION: Be sure to use appropriate dust mask when cutting fiberglass.)

FIGURE 15



S. Cut inside the visible lines using the hole saw to create lightening holes (Figure 16)

FIGURE 16



T. Have instructor evaluate your work

U. Clean equipment and shop area; return equipment and materials to instructor

PROJECT GUIDE #3--Perform a Liquid-Penetrant Inspection

PURPOSE: To give the student actual experience of liquid penetrant inspection which is used to detect defects too small to be found by normal visual inspection.

REFERENCE MANUALS:

A. AC 43-3

B. AC 65-9A

C. AC 43.13-1A

D. Manufacturer's reference manual for piston being inspected

EQUIPMENT AND TOOLS NEEDED:

A. Piston to be inspected

(NOTE: Piston should be degreased and decarbonized.)

B. Solvent-removable liquid-penetrant kit

(NOTE: Liquid-penetrant kit consists of one can of penetrant, one can of cleaner, and one can of dry developer.)

C. Air hose with air nozzle attachment

SUPPLIES AND MATERIALS:

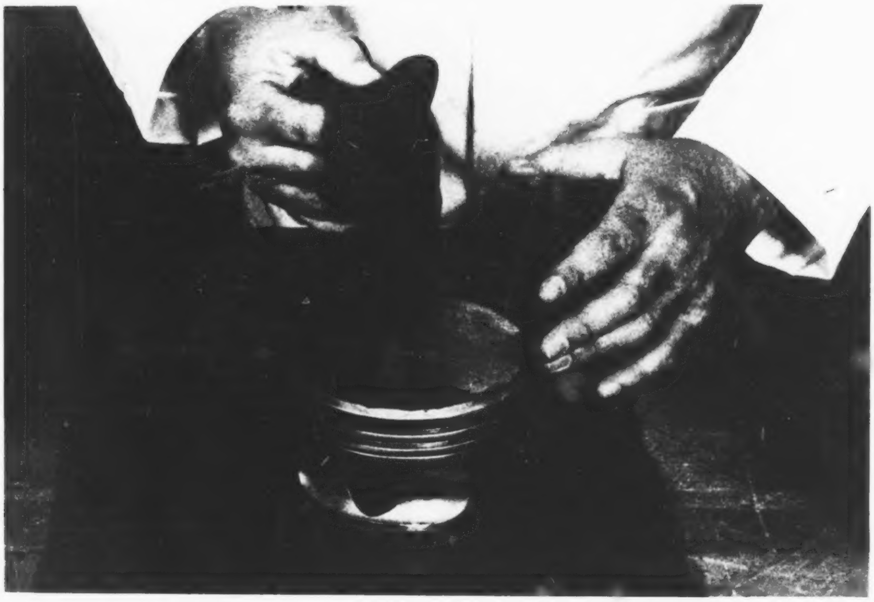
A. Clean shop towels

B. Pencil, paper, and clipboard

PROCEDURE:

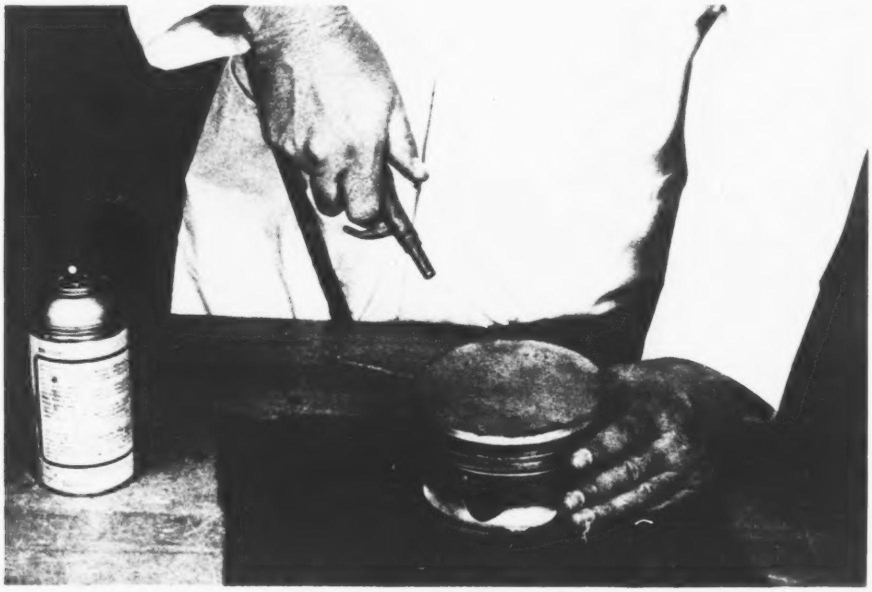
A. Clean piston according to liquid-penetrant kit instructions (Figure 17)

FIGURE 17



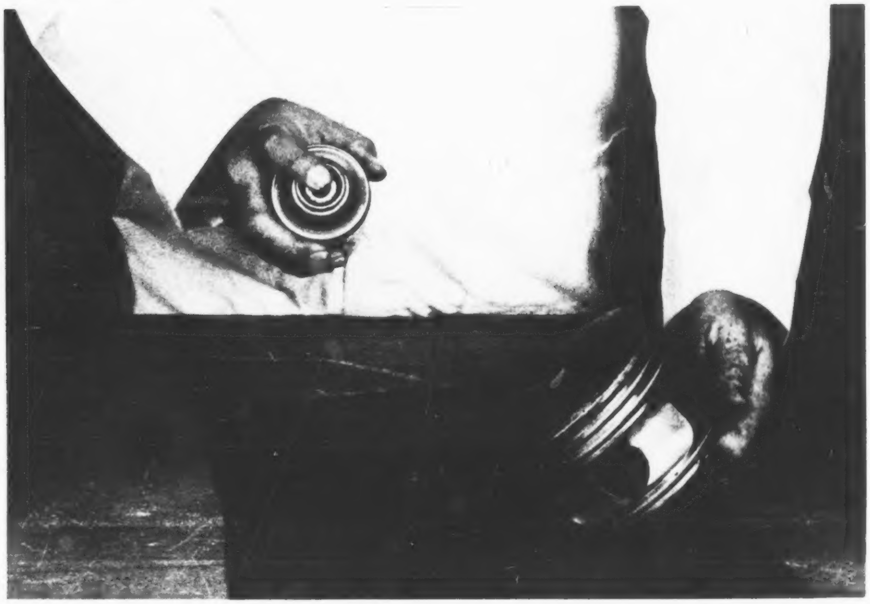
B. Dry piston surface with air hose (Figure 18)

FIGURE 18



C. Spray a thin, uniform coating of solvent-removable penetrant on surface of piston (Figure 19)

FIGURE 19

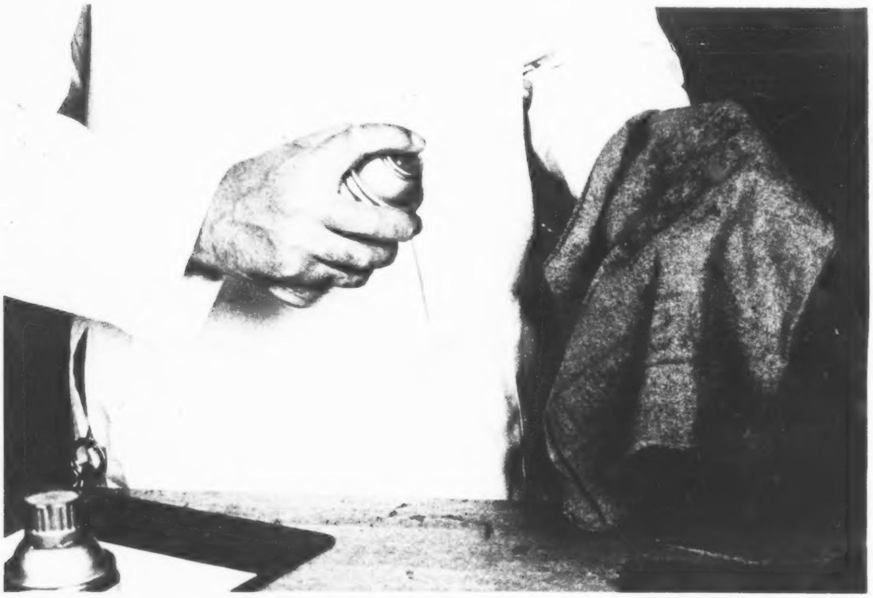


D. Allow penetrant to dwell an appropriate amount of time

(NOTE: Dwell time is the amount of time necessary for the penetrant to seep into the defects. The smaller the defect, the longer the dwell time.)

E. Spray cleaner on a clean shop towel (Figure 20)

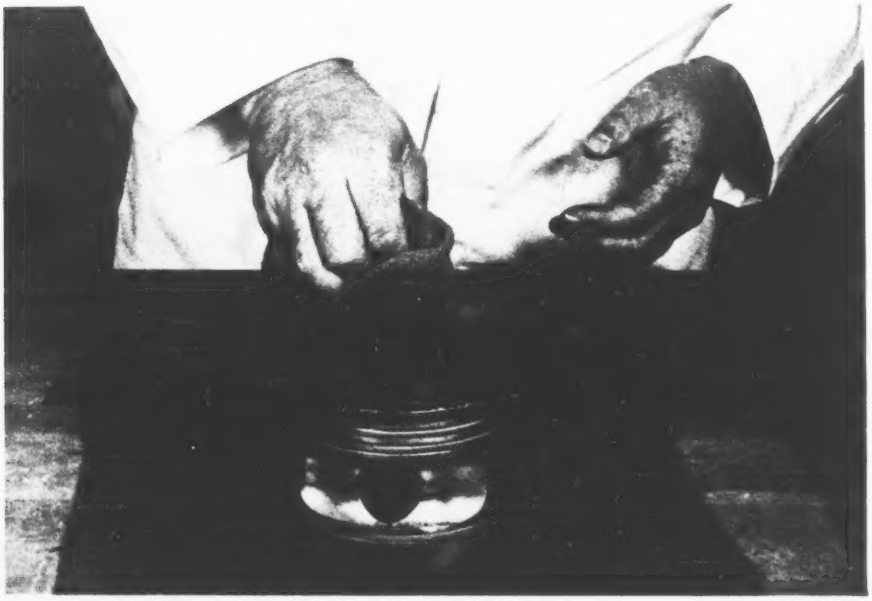
FIGURE 20



F. Use shop towel moistened with cleaner to remove excess penetrant from surface (Figure 21)

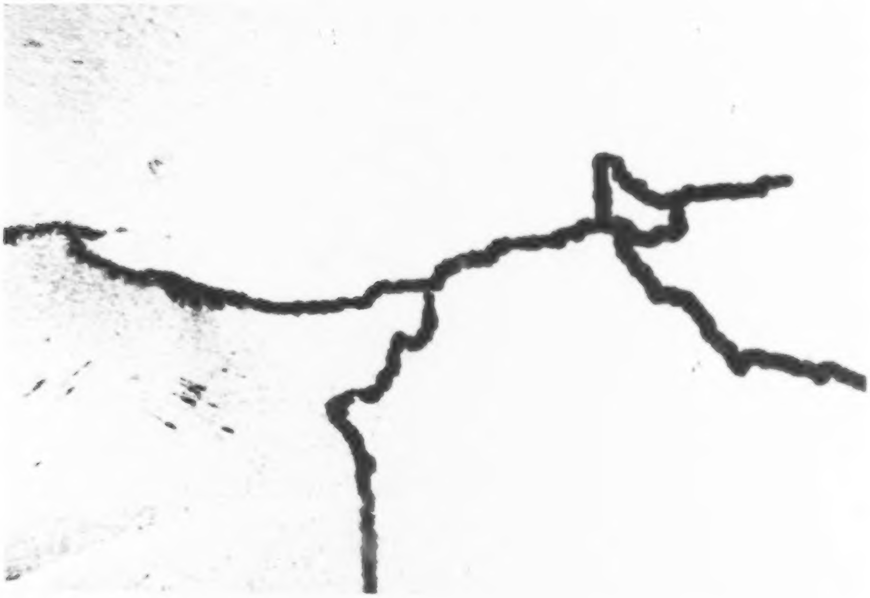
(NOTE: The surface of the piston should never be sprayed, as it will wash the penetrant out of the fault or dilute it enough that it will not make a proper indication in the developer.)

FIGURE 21



G. Spray a fine, uniform coating of non-aqueous developer on the piston surface and evaluate any possible flaw indications (Figure 22)

FIGURE 22



H. Inform your instructor of the condition of the piston being inspected

I. Clean equipment, return equipment and materials to instructor

PROJECT GUIDE #4--Perform a Magnetic Particle Inspection

PURPOSE: Due to the high stress and long service life of aircraft components, a method was developed for detecting invisible cracks and other defects in ferromagnetic materials. This method of inspection is a nondestructive test, which means if it is performed properly the part which is being inspected will not be damaged. This project is to provide you with the skills necessary to accomplish this type of inspection.

REFERENCE MANUALS:

A. AC 43.13-1A

B. AC 65-9A

C. AC 43-3

D. Magnetic particle inspection equipment manual

E. Engine manufacturer's overhaul manual

EQUIPMENT AND TOOLS NEEDED:

A. Magnetic particle inspection machine

B. Aircraft engine crankshaft, cleaned and decarbonized

C. Standard magnetic field indicator

D. 10X magnifying glass

E. AC coil

SUPPLIES AND MATERIALS:

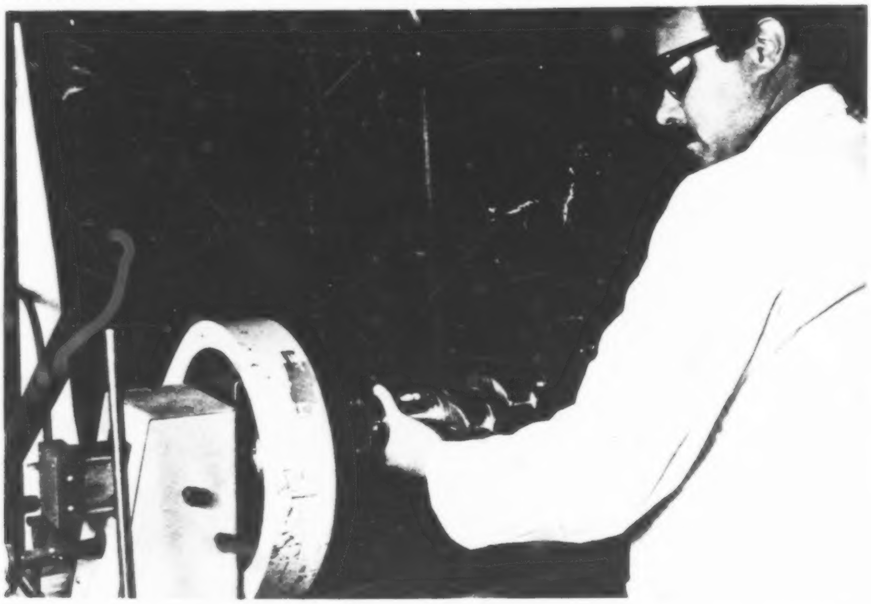
A. Clean shop towels

B. Gray, black, or red iron oxide suspensoid

PROCEDURE:

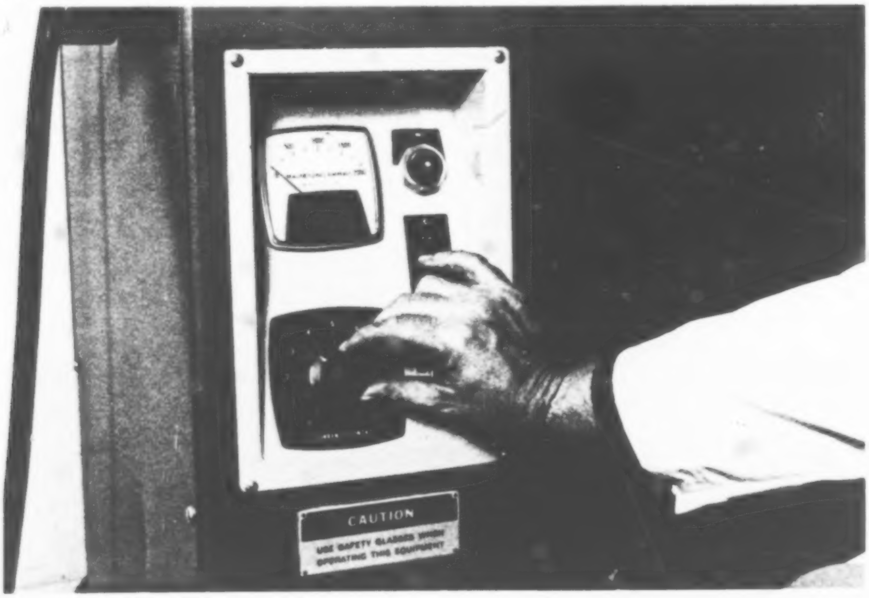
A. Install crankshaft between heads of magnetic particle machine (Figure 23)

FIGURE 23



B. Apply recommended current to crankshaft as stated in the engine manufacturer's overhaul manual (Figure 24)

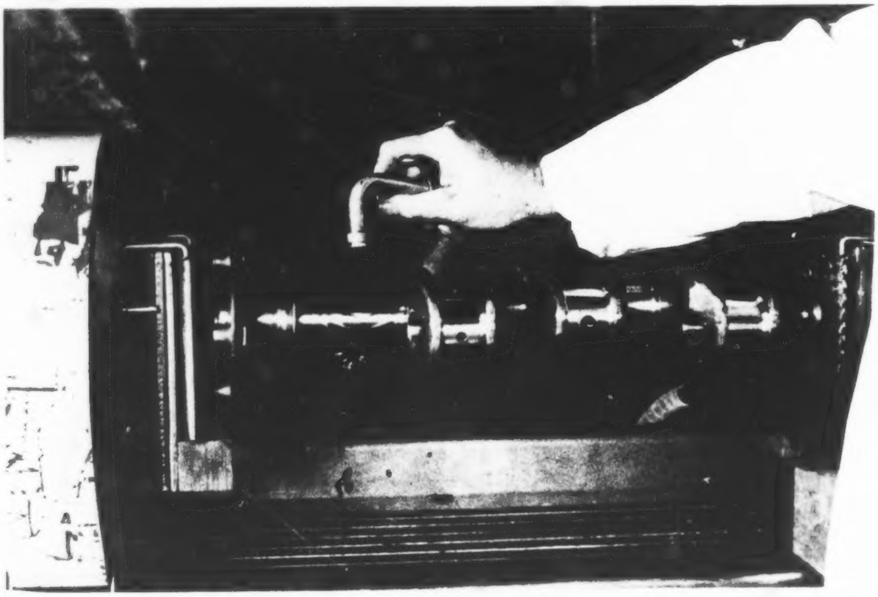
FIGURE 24


CAUTION
USE SAFETY GLASSES WHEN OPERATING THIS EQUIPMENT

C. Apply suspensoid while maintaining current flow (Figure 25)

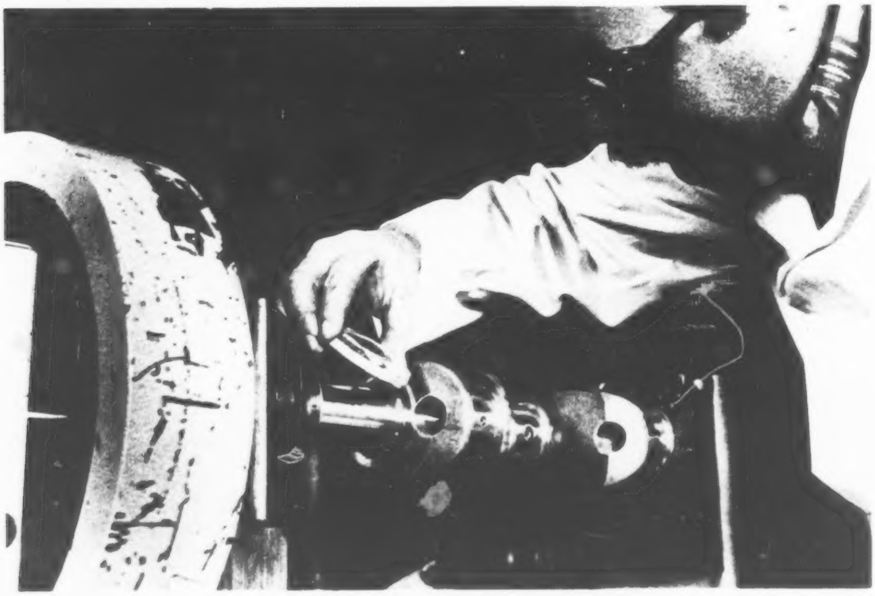
(NOTE: This is called the continuous magnetization method.)

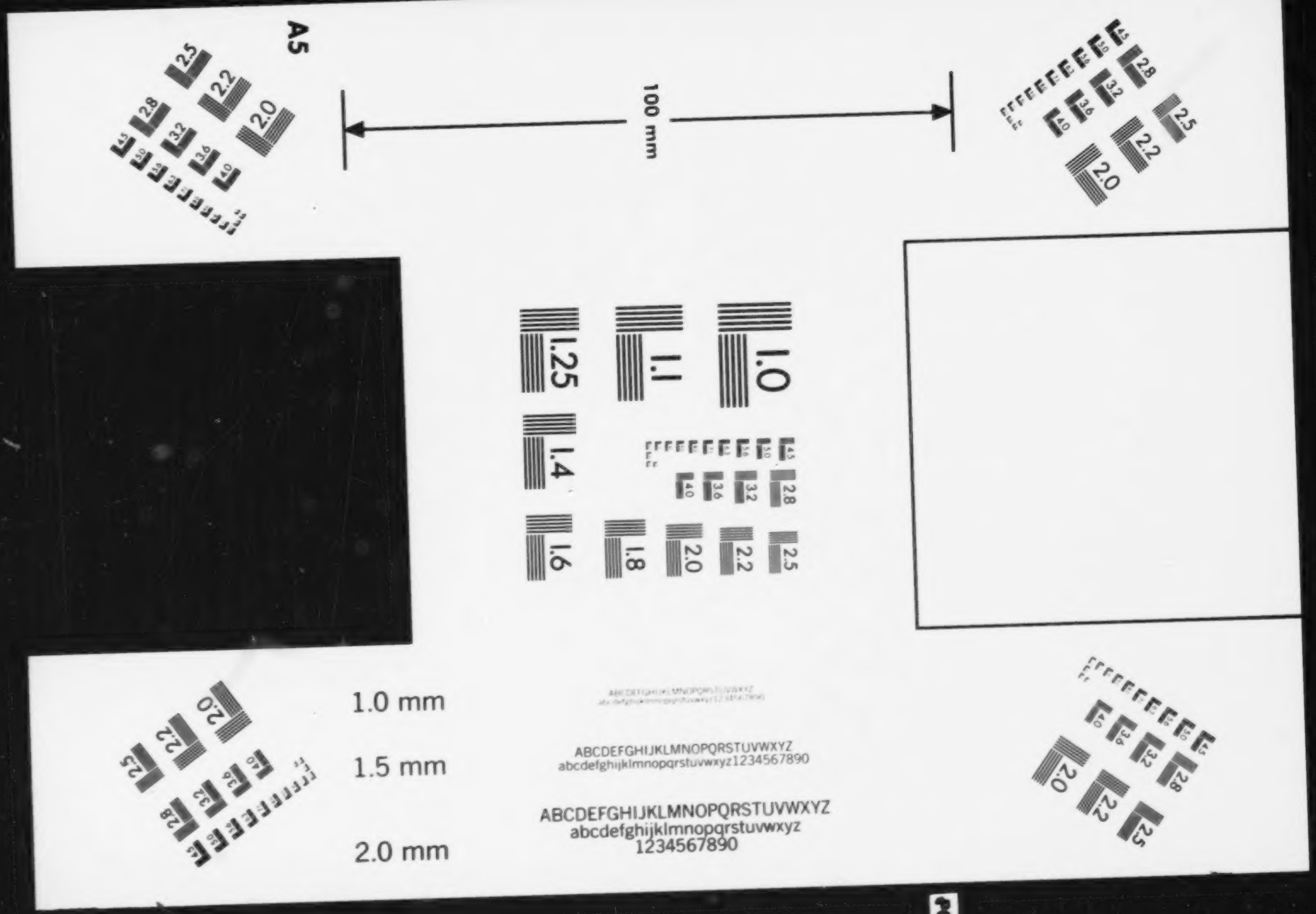
FIGURE 25



D. Using the 10X magnifying glass, inspect crankshaft for any indication of discontinuities (Figure 26)

FIGURE 26



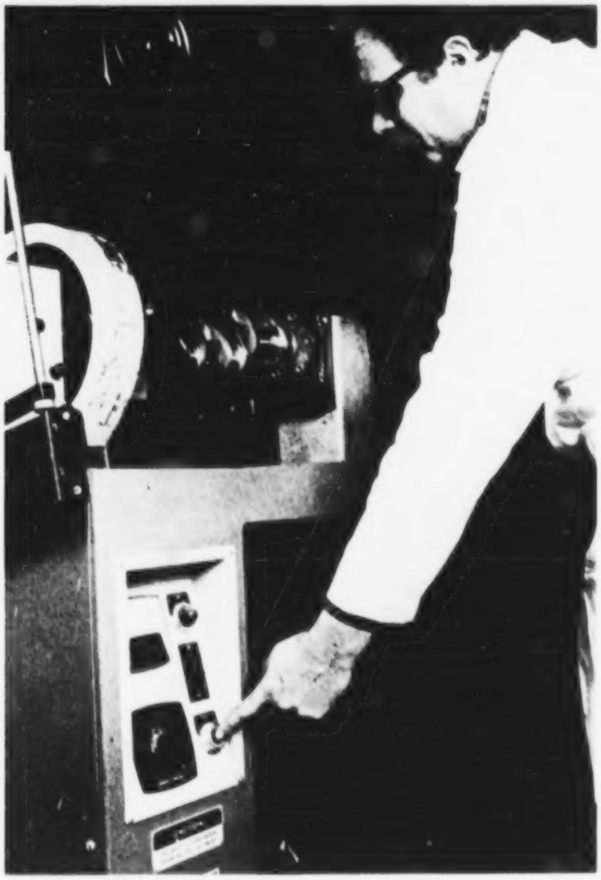

A5
100 mm
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
1.0 mm
1.5 mm
2.0 mm
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz1234567890
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

E. Inform instructor of inspection results before proceeding

F. Demagnetize the crankshaft using the demagnetizing mode (Figure 27)

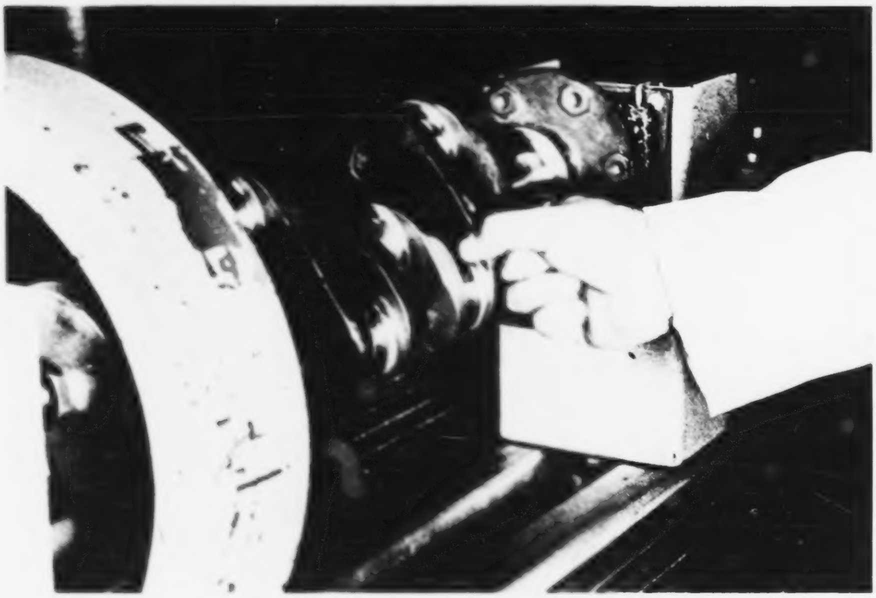
(NOTE: If your machine does not have a demagnetizing mode, use an AC coil. Be sure to check manufacturer's operating manual for your machine.)

FIGURE 27



G. Check for presence of any residual magnetism with a standard magnetic field indicator (Figure 28)

FIGURE 28



H. Repeat steps F and G if residual magnetism is detected

I. Return equipment and materials to instructor

PROJECT GUIDE #5--Perform Visual Inspections of Welded Assemblies

PURPOSE: One of the quickest and most economical nondestructive testing methods is the visual inspection. The appearance of a completed weld gives a clue as to the care used in making the weld, but appearance alone is not a positive indication of strength. This project will allow you to develop skill in detecting welds which are determined to be unsatisfactory by a visual inspection.

REFERENCE MANUALS:

A. AC 43.13-1A

B. AC 65.9A

C. AC 43.3

EQUIPMENT AND TOOLS NEEDED:

A. Small welded aircraft structures

B. Flashlight

C. Mirror

D. 10X magnifying glass

SUPPLIES AND MATERIALS:

A. Clean shop towels

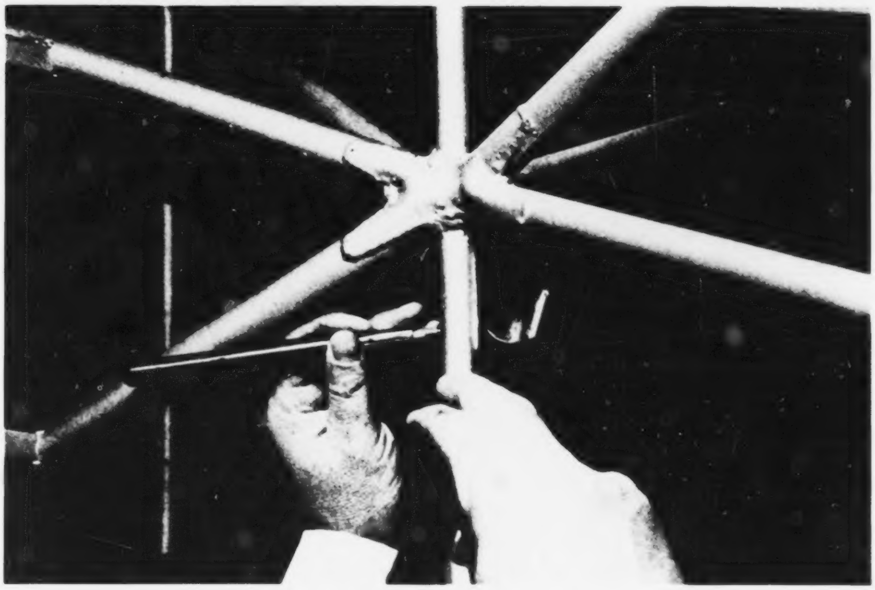
B. Pencil, paper, and clipboard

PROJECT GUIDE #5

PROCEDURE:

A. Examine all welds on specified structure(s), using the flashlight, mirror, and 10X magnifying glass, as required (Figure 29)

FIGURE 29



(NOTE: Check each weld for the following characteristics of a good weld:

1. Seam is smooth, bead ripples are evenly spaced and of a uniform thickness
2. Weld is built up, providing extra thickness at the joint
3. Weld tapers off smoothly into base metal
4. No oxide formed on base metal close to weld
5. Weld shows no signs of blowholes, porosity, or projecting globules
6. Base metal shows no signs of burns, pits, cracks, or distortion.)

B. Using the attached disrepancy sheet, record all weld defects by the type of defect and weld number

C. Discuss the defective welds with your instructor

D. Return equipment and materials to instructor

PROJECT GUIDE #5--Discrepancy Sheet

1. ______________________________

____

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2. ______________________________

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3. ______________________________

____

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4. ______________________________

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5. ______________________________

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6. ______________________________

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7. ______________________________

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8. --

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

THEORY TEST

1. Match terms related to aircraft structural materials to their correct definitions. Write the correct numbers in the blanks.

_____a. Amount of force required to shear a pin, bolt, or rivet

_____b. Property of a metal which allows it to be deformed without breaking

_____c. Metal which contains no iron

_____d. Mass of a substance per unit of its volume; weight per unit volume expressed in pounds per cubic foot

_____e. Ability of an object to resist forces tending to stretch or lengthen it

_____f. Property of a metal to break when bent, deformed, or hammered; or resistance to change in the relative position of the molecules within the materials

_____g. Load on a material, which causes the initial indication of permanent distortion

_____h. Force required to pull a rivet through the edge of the sheet or to elongate the hole

_____i. Metal which contains iron

1. Tensile strength
2. Density
3. Bearing strength
4. Ferrous metal
5. Yield strength
6. Toughness
7. Brittleness
8. Nonferrous metal
9. Shear strength

THEORY TEST

_____j. Characteristics of a material to carry heat with a minimum loss

_____k. Property which allows metal to be drawn into thinner sections without breaking

_____l. Characteristic of a metal to conduct electricity with a minimum of opposition or resistance

_____m. Expansion of any substance due to heat

_____n. Ability of a material to be fused or welded

_____o. Property of a metal that enables it to resist penetration, wear or cutting actions

_____p. Characteristic of material that allows it to be stretched or shaped, by beating with a hammer or passing through rollers, without breaking

_____q. Capability of an object or material to be stretched and to recover its size and shape after its deformation

10. Fusiblity

11. Thermal expansion

12. Thermal conductivity

13. Elasticity

14. Malleable

15. Electrical conductivity

16. Hardness

17. Ductility

2. State general facts related to ferrous and nonferrous metals. Write the correct answers in the blanks.

a. How is iron converted into steel? ______________________________

____

____

____

____

b. What is the major disadvantage of ferrous materials when used in aircraft structures? ______________________________

____

____

____

c. What are the two main characteristics of the most common nonferrous metal, aluminum?

1) ____

2) ____

3. State facts related to aluminum alloys. Write the correct answers in the blanks.

a. What country developed the first aluminum alloys? ______________

b. How are nonheat-treatable alloys softened? ______________

____

c. How are nonheat-treatable alloys hardened? ______________

____

d. What can be done to a heat-treatable alloy using heat?

____

e. What is one disadvantage of aluminum alloys?

____

f. What is Alclad?

____

4. Distinguish between heat-treatable and nonheat-treatable alluminum alloys by referring to their material code. Place an "H" for heat-treatable or an "N" for nonheat-treatable in the blanks next to the material codes listed below.

_____a. 1100

_____b. 2024

_____c. 2017

_____d. 3003

_____e. 5052

_____f. 6061

_____g. 7075

_____h. 2117

5. State facts related to thermal treatments of aluminum alloys. Write the correct answers in the blanks.

a. How long after quenching does one have to drive alloy 2024 rivets?

____

b. What needs to be done to alloy 2024 rivets before being used if they are not driven in the time allotted after quenching?

____

c. What is the result of allowing too much time to elapse during the transfer of 2017 or 2024 aluminum alloy from the heat-treatment medium to the quench tank?

____

____

d. How many times are clad sheets allowed to be reheat-treated?

____

e. Why are clad sheets only heat-treated a limited number of times?

____

____

f. What does it mean to solution-heat-treat an aluminum alloy?

____

____

____

g. What does it mean to use the precipitation heat treatment (artificial aging) on an aluminum alloy?

____

____

____

h. When annealing an aluminum alloy, the temperature of the alloy is raised to the annealing temperature and held there until the temperature of alloy is uniform throughout. The next step is cooling the metal. To what temperature and at what rate is the metal cooled?

1) Temperature ____________

2) Rate ________________

3) If the temperature is below 500°F, is the rate of cooling important? ______________________

6. Match temper designations to treatment processes for aluminum alloys. Write the correct numbers in the blanks.

_____a. Stain-hardened only

_____b. Solution-heat-treated and then stabilized

_____c. As fabricated

_____d. Strain-hardened and stabilized

_____e. Solution-heat-treated, artificially aged, and then cold-worked

_____f. Strain-hardened and partially annealed

_____g. Solution-heat-treated

_____h. Annealed

_____i. Solution-heat-treated and then artifically aged

1. T7
2. H2
3. F
4. T9
5. O
6. H_1
7. T6
8. H3
9. T4

7. Select statements related to magnesium and magnesium alloys. Circle the numbers before the correct answers.

a. Which of the following qualities of magnesium alloy are improved by precipitation heat treatment?

1) Ductility and toughness

2) Ductility and yield strength

3) Hardness and yield strength

4) Hardness, ductility, and yield strength

b. The type of heating medium which must never be used on magnesium alloys is

1) Oven-type furnace

2) Oil bath

3) Lead bath

4) Salt bath

8. State facts related to titanium and titanium alloys. Write the correct answers in the blanks.

   a. What are the most important characteristics of titanium?

   ____

   ____

   ____

   ____

   b. When welding titanium or performing other thermal treatments in which the temperature will exceed 1,000°F, what special technique must be used?

   ____

   ____

   ____

   ____

9. State facts related to nickel and nickel alloys. Write the correct answers in the blanks.

   a. Which nickel alloy contains about 68 percent nickel, 29 percent copper, and small amounts of iron and manganese; can be welded; and has very good machining characteristics? ____________________

   b. Inconel is frequently used in which parts of a turbine engine?

   ____

   c. Why is inconel used in these parts? ____________________

   ____

   ____

   ____

10. State facts related to copper and copper alloys. Write the correct answers in the blanks.

   a. What is the name for an alloy of copper and tin? ______________

b. What are copper alloys used for in the aircraft industry?

----

c. What happens to copper tubing when it is subjected to vibration?

----

11. Match eleven alloying agents found in steel to their effect on steel alloys. Write the correct numbers in the blanks.

_____a. Raises the yield strength and improves the resistance of low-carbon steel to atmospheric corrosion. Causes steel to become brittle when cold

_____b. Eliminates some of the oxides and sulfur from the steel. Makes steel clean, tough and uniform. Improves forging characteristics

_____c. Allows steel to be heat-treated to obtain varing degrees of hardness, strength, and toughness

_____d. An undesirable agent. Causes steel to be brittle when being rolled or forged

_____e. Reduces the grain size of the steel and increases both its impact strength and its elastic limit. Has some of the best wear resistance and fatigue strength of any of the alloys

_____f. Provides extremely high strength, toughness, and good ductility. Improves grain structure and increases both tensile strength and toughness when used in amounts up to 0.020 percent

_____g. Appreciably raises the melting point of steel

_____h. Adds strength and hardness. Slows the critical rate of hardening in the heat treatment processes. One of the chief ingredients in corrosion-resistant steel

_____i. Increases strength, wear resistance, and resistance to corrosion. Can be electrolytically deposited on steel to give it a hard, wear-resistant surface

_____j. A non-metallic element which acts as a hardener. Improves the ductility of steel when used in small quantities

_____k. Provides high strength at elevated temperatures. A small amount of this element reduces the brittleness of steel

1. Carbon
2. Sulfur
3. Manganese
4. Silicon
5. Phosphorous
6. Nickel
7. Chromium
8. Molybdenum
9. Vanadium
10. Titanium
11. Tungsten

12. Select statements related to alloying agents, carbon steels, alloy steels, and the SAE classification system used for steel. Circle the numbers before the correct answers.

    a. Carbon mixes with iron to form compounds of iron carbides called

        1) Steel

        2) Iron oxide

        3) Cementites

        4) Ferrites

    b. The Society of Automotive Engineers and the American Iron and Steel Institute use a numerical index system to identify the composition of various steels. The symbol 1020 indicates a plain carbon steel containing an average of

        1) 20 percent carbon

        2) 2 percent carbon by volume

        3) 2 percent carbon by weight

        4) 0.20 percent carbon by weight

    c. Increasing the carbon content of steel results in

        1) Reduced heat-treatability

        2) Softer material

        3) Greater malleability

        4) Reduced weldability

    d. Sulfur is alloyed with steel to

        1) Eliminate some of the oxides and sulfur

        2) Add strength

        3) Increase the yield

        4) Reduce the melting point

e. Which of the following is generally used in the construction of aircraft engine firewalls?

1) Aluminum alloy sheet

2) Stainless steel

3) Chrome-molybdenum alloy steel

4) Magnesium-titanium alloy steel

f. The addition of molybdenum as an alloying agent results in the steel being

1) More brittle

2) More resistant to corrosion

3) More elastic

4) More heat-treatable

13. Select statements related to treatment processes for steel. Circle the numbers before the correct answers.

a. Nitriding is a process which

1) Forms a hard case on a part to resist wear

2) Decreases the size of the grain structure

3) Toughens steel to increase its tensile strength

4) Increases heat resistance of bearings

b. Which type of steel is best suited for case hardening?

1) High-carbon, low-alloy

2) Low-carbon, low-alloy

3) Low-carbon, high-alloy

4) High-carbon, high-alloy

c. The difference between annealing and normalizing steel is that normalizing usually requires temperatures

1) Higher than critical point, with slower cooling

2) Lower than critical point, with faster cooling

3) Lower than critical point, with slower cooling

4) Higher than critical point, with faster cooling

d. Why is steel tempered after being hardened?

1) To increase its hardness and ductility

2) To decrease its ductility and brittleness

3) To relieve its internal stresses and reduce its brittleness

4) To increase its strength and decrease its internal stresses

e. What will determine the hardness of steel at ordinary temperatures?

1) The number of particles of iron carbide in the mixture

2) The size of the particles of iron austenite in the mixture

3) The distribution of the particles of iron matrix throughout the mixture

4) The transformation of pearlite to austenite in the mixture

14. State facts related to the principles of heat treatment of metals. Write the correct answers in the blanks.

a. What happens to the structure of a pure metal if it is heated above its critical temperature and cooled to room temperature?

____

____

b. What is the name for a substance in which two or more elements are mixed, but each element can be identified by microscopic examination?

____

c. At what temperature does steel begin to appear a dull red color?

____

15. Select statements related to commonly used systems for measuring the hardness of steel. Circle the numbers before the correct answers.

    a. Metal to be tested on the Rockwell Hardness Tester must meet which of the following specificiation(s)?

        1) It must be ground smooth on one side only and cleaned

        2) The two opposite ground surfaces must be free of scratches and foreign matter

        3) The two opposite surfaces must be parallel but not necessarily cleaned

        4) The two opposite ground surfaces should be perpendicualr and cleaned

    b. The Barcol tester is used to test

        1) Copper, iron, monel

        2) Aluminum alloys, stainless steel, babbit

        3) Copper, chrome-molybdenum steel, cast iron

        4) Brass, copper, aluminum alloys

    c. The test which measures the diameter of an indentation caused by a prescribed pressure is the

        1) Brinnell

        2) Barcol

        3) Rockwell

        4) Bernoulli

16. Perform basic heat-treating.

    (NOTE: Test question 16 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

17. Match the three types of wood used in aircraft construction to their correct descriptions. Write the correct numbers in the blanks.

____ a. Three or more layers of thin veneer glued together so the grain of each successive layer crosses the others at an angle of 45° to 90°.

____ b. Used for some aircraft wing spars. One piece, cut from the tree by a method known as quarter sawing.

____ c. Two or three pieces of thin wood glued together with the grain of all pieces running in the same direction.

1. Laminated wood
2. Plywood
3. Solid wood

18. Match wood species to their correct descriptions. Write the correct numbers in the blanks.

____a. Most important wood for aircraft structure, and because it is available in large sizes and free from defects and because of its high strength-to-weight ratio, it has been chosen by the FAA as the reference wood for aircraft construction

____b. Has excellent working and gluing characteristics, but its strength is slightly lower than that of spruce

____c. Slightly lighter than spruce, and it is equal to or superior to spruce in all properties except hardness and shock resistance. It is especially good for such structural parts as spars, spar flanges, and cap strips which must carry heavy loads in bending and compression

____d. Strength properties exceed those of spruce, but it is much heavier. It is more difficult to work than spruce, and it has a tendency to split

____e. Heavier than spruce but is stronger. Its primary use in aircraft construction is for the face sheets of plywood used for aircraft skin

____f. Heavy hardwood with very good shock resistance characteristics, and it is recommended for the face plies of plywood used for reinforcement plates on wing spars and in the construction of wooden propellers

____g. Extremely light wood grown in South America. It has no structural strength; but it is often sliced across its grain for use as the core for sandwich-type panels where light weight and rigidity are needed

1. Douglas fir
2. Noble fir
3. Mahogany
4. Balsa
5. Spruce
6. Northern white pine
7. Birch

THEORY TEST

19. State facts related to wood construction in aircraft. Write the correct answers in the blanks.

    a. What is the maximum grain deviation allowed for aircraft structural material? ______________________________

    b. How can grain deviation be determined on a piece of wood?

    ____

    ____

    ____

    c. What causes a knot in a piece of wood? ____________________

    ____

    ____

    d. What is a split in a piece of wood? ____________________

    ____

    ____

    e. What is a check in a piece of wood? ____________________

    ____

    ____

    f. What is a simple way of determining whether a stain in a piece of wood is an indication of decay? ____________________

    ____

    ____

    ____

    ____

    g. How does a compression failure appear on a piece of wood?

    ____

    ____

20. Name the two major classifications of plastic resins used in aircraft construction. Write the correct answers in the blanks.

    a. ______________________________

    b. ______________________________

21. Select statements related to aircraft plastics. Circle the numbers before the correct answers.

    a. Which properly catalyzed polyester resin will cure more quickly?

        1) Polyester resin without accelerator

        2) A thin layer of polyester resin

        3) A thick layer of polyester resin

        4) None of the above

    b. What must be done to thermosetting resins for them to develop the strength needed for use as aircraft structural material?

        1) They must be reinforced with a material such as cloth, paper or glass fiber

        2) They must have thixotropic agents added to them

        3) They must be cured at temperatures above 150°F

        4) They must be cured until all catalyst precipitates from the resin

    c. Which type of plastic resin will become soft when it is heated?

        1) Thermosetting

        2) Thermoplastic

        3) Thermodyne

        4) Thermolight

    d. What is the function of an accelerator in a polyester resin?

        1) To activate the inhibitors

        2) To thin the resin

        3) To provide strength

        4) To shorten the time required for solidification

e. What is the process of a thixotropic agent mixed with a thermosetting resin?

  1) To increase material strength for materials used in tropical climates

  2) To shorten solidification time

  3) To thicken the resin

  4) To make the resin lighter

f. What are two types of transparent thermoplastics used for aircraft windows?

  1) Cellulose Acetate, and Acrylic

  2) Epoxy and polyester

  3) Acrylic and polyester

  4) Epoxy and Cellulose Acetate

22. Perform a foam core/glass fiber lay-up or simple fiberglass repair.

(NOTE: Test question 22 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

23. Match terms related to nondestructive testing to their correct definitions. Write the correct numbers in the blanks.

______a. Method of detecting surface cracks in which a penetrating liquid or dye is allowed to enter any cracks present, and is pulled out of the crack by an absorbent developer; crack appears as a line on the surface of the developer

______b. Form of nondestructive inspection for ferrous metal parts in which the part is magnetized, producing north and south poles across any discontinuity, either on the surface or subsurface; iron oxide is attached and held over the discontinuity

______c. System of nondestructive inspection using x-rays or gamma rays to determine the condition of a part not visible without dissembly

______d. Inspection of a part or component by visual means only; inspection by magnification using a 10X-20X glass

______e. Form of nondestructive inspection in which a part is thoroughly cleaned and immersed in a vat of penetrating oil. When the part has soaked for a sufficient time, it is removed, the oil is washed from the surface, and the part is dried. It is then covered with a developer that will draw the oil from any crack into which it may have seeped. The part is inspected under ultraviolet light which will cause the crack to appear as a vivid green line

______f. Form of nondestructive inspection in which the condition of a material is determined by its ability to conduct vibrations normally at frequencies above those to which the human ear responds

1. Magnetic particle inspection
2. Liquid penetrant/dye penetrant inspection
3. Fluorescent penetrant inspection
4. Visual inspection
5. Ultrasonic inspection
6. Radiography

THEORY TEST

_____g. Form of nondestructive inspection used to locate surface or subsurface defects in a metal part

_____h. Break or opening in the surface or subsurface of a material

_____i. Substance that will glow when excited by a black light

_____j. Any imperfection, fault, flaw, or blemish which may require repair or replacement of a part

_____k. Electromagnetic radiation of extremely short wave length, capable of penetrating solid objects and exposing photographic film

_____l. Agent which will, when added or applied to an oil-like penetrant material, make the penetrant removable from surfaces by water rinsing

7. Emulsifier

8. Discontinuity

9. Fluorescent

10. X-ray

11. Eddy current inspection

12. Defect

_____m. Ultraviolet light whose rays are in the lower end of the visible spectrum. While more or less invisible to the human eye, these rays excite, or make visible, certain materials such as fluorescent dyes

_____n. Oil-like material containing an emulsifying agent which makes it washable by water rinsing

_____o. Solvent-type liquid used to clean penetrants from the surface of a material

_____p. Ability of the penetrant, processing technique, and developer to detect surface-connected discontinuities and provide an indication visible to the unaided eye

_____q. Oil-like material which, after application to a surface, can be made water-washable by the application of an emulsifier

_____r. Powder sprayed on a surface which has been treated with a penetrating dye. The powder acts as a blotter, pulling penetrant out of any crack, exposing the crack

13. Post-emulsifiable material

14. Water-washable material

15. Penetrant sensitivity

16. Penetrant remover

17. Developer (dye check)

18. Black light

24. Match inspection methods to their advantages and disadvantages.

(NOTE: Test question 24 is a workbook supplement. It is an important part of this test. If it has not been completed, check with your instructor.)

25. State facts related to visual inspection. Write the correct answers in the blanks.

a. What is the limitation of a visual inspection? ________________

____

____

____

b. What is the principle on which a fiberoptic borescope operates?

____

____

____

____

____

26. List the steps in performing a liquid-penetrant inspection. Write the correct answers in the blanks.

a. ____

b. ____

c. ____

d. ____

27. Select statements related to dye-penetrant inspection. Circle the numbers before the correct answers.

a. The main disadvantage of dye-penetrant inspection is that

1) The chemicals used are dangerous to the inspection personnel

2) The defect must be open to the surface

3) It does not work on nonferrous metals

4) It is excessively time consuming

b. If dye-penetrant inspection indications are not sharp and clear, the most probable cause is that

1) The part was not correctly degaussed before the developer was applied

2) The part is not damaged

3) The part is badly damaged over an extensive area of its surface

4) The part was not thoroughly washed before developer was applied

c. Before applying dye penetrant to an aluminum part, first

1) Clean the part thoroughly

2) Apply the developer

3) Mix the penetrant with water

4) Mix the penetrant with the developer

d. When using the dye-penetrant test, it is well to remember that the

1) Smaller the defect, the shorter the required penetrating time

2) Larger the defect, the longer the required penetrating time

3) Smaller the defect, the longer the required penetrating time

4) Penetrating time is independent of the size of the defect

e. What is the purpose of the developer as used in dye-penetrant inspection?

1) It removes penetrant from surface

2) It causes penetrant to glow in the dark

3) It causes penetrant on the surface to seep into cracks

4) It brings out the penetrant to show defects

f. Dye-penetrant inspection method will detect

1) Surface defects

2) Subsurface flaws

3) Deteriorated molded rubber

4) Cracks in any porous material

28. Match types of penetrants to their characteristics. Write the correct numbers in the blanks.

_____a. This penetrant may be treated with an agent that will allow the penetrant to be washed from the surface by rinsing it with water. If the proper dwell time is allowed for (in relation to the agent which is applied to the penetrant) the penetrant on the surface will be readily rinsed off with water while the penetrant in the crack will remain

_____b. This penetrant is simply removed with water. The surface of the part is flushed with water at a pressure of 30 to 40 psi with an adjustable spray nozzle held about 45 degrees to the surface

_____c. This penetrant must be removed from the part with a liquid specifically recommended for this material. The surface should never be sprayed with nor immersed in the solvent, as it will wash the penetrant out of the fault or dilute it enough that it will not make a proper indication in the developer

1. Solvent removable penetrant

2. Post-emulsifying penetrant

3. Water-soluble penetrant

29. Perform a liquid-penetrant inspection.

(NOTE: Test question 29 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

30. State facts related to the principles of magnetism. Write the correct answers in the blanks.

a. What takes place inside a piece of ferrous metal when it is magnetized? ____

____

b. What unit is used in the measurement of magnetic flux density?

____

c. Why is the magnetic strength produced by current flowing through a conductor increased when the conductor is wound into a coil?

____

____

____

31. Match terms used in magnetic particle inspection to their correct definitions. Write the correct numbers in the blanks.

_____a. Reverse magnetizing force required to remove the residual magnetism from a material

_____b. Ability of a material to retain some residual magnetism after the magnetizing force is removed

_____c. Ease with which a material will conduct lines of magnetic flux

_____d. Invisible lines of magnetic force that exist between the poles of a magnet

_____e. Magnetism that remains in a material after the magnetizing force is removed

_____f. Number of lines of magnetic flux per unit area

1. Magnetic flux
2. Flux density
3. Retentivity
4. Coercive force
5. Residual magnetism
6. Permeability

32. Select statements related to longitudinal and circular magnetization. Circle the numbers before the correct answers.

a. What defects will be detected by magnetizing a part using continuous longitudinal magnetization with a cable?

1) Defects perpendicular to the long axis of the part

2) Defects perpendicular to the concentric circles of magnetic force within the part

3) Defects parallel to the concentric circles of magnetic force within the part

4) Defects parallel to the long axis of the part

b. When checking an item with the magnetic particle inspection method, circular and longitudinal magnetization should be used to

1) Reveal all possible defects

2) Prevent permanent magnetization

3) Prevent one-way polarization

4) Ensure uniform current flow

c. Circular magnetization of a part can be used to detect which of the following defects?

1) Defects parallel to the concentric circles of magnetic force within the part

2) Defects perpendicular to the long axis of the part

3) Defects parallel to the long axis of the part

4) Defects perpendicular to the concentric circles of magnetic force within the part

d. Which type of crack can be detected by magnetic particle inspection using either circular or longitudinal magnetization?

1) Longitudinal

2) 45 degrees

3) Transverse

4) Circumferential

33. State facts related to magnetic field strengths and sources of current for magnetization. Write the correct answers in the blanks.

a. What is the magnetic field strength in the center of a hollow magnetic conductor through which direct current is flowing?

____

b. Where is the greatest field strength around a solid nonmagnetic conductor through which direct current flows?

____

c. What are three types of current that can be used to magnetize a part for magnetic particle inspection?

1) ______________________________

2) ______________________________

3) ______________________________

34. Select statements related to magnetic particle inspection and demagnetization. Circle the numbers before the correct answers.

a. Under magnetic particle inspection a part will be identified as having a fatigue crack under which of the following conditions?

1) The discontinuity pattern is straight

2) The discontinuity is found in a nonstressed area of the part

3) The discontinuity is found in a highly stressed area of the part

4) The discontinuity pattern is not clear

b. The pattern for an inclusion is a magnetic particle buildup forming

1) A fernlike pattern

2) A single line

3) A smooth ouline

4) Parallel lines

c. Which type of current is usually used to demagnetize aircraft parts?

1) Alternating, decreasing

2) Direct, increasing

3) Alternating, increasing

4) Direct, decreasing

d. Which type crack will probably cause the most buildup in the magnetic particle indicating medium?

1) Heat-treated

2) Shrink

3) Fatigue

4) Grinding

e. Which of the following metals can be inspected using the magnetic particle inspection method?

1) Magnesium alloys

2) Aluminum alloys

3) Iron alloys

4) Copper

f. What two types of indicating mediums are available for magnetic particle inspection?

1) Iron and ferric oxides

2) Wet and dry process materials

3) Penetrant and fluorescent material

4) High retentivity and low permeability material

g. Magnetic particle inspection is used primarily to detect

1) Distortion

2) Irregular surfaces

3) Porosity and thickness of ferromagnetic metals

4) Flaws on or near the surface

h. What types of discontinuities are formed by a parting or a rupture of the metal being magnetically tested?

1) Lap or voids

2) Cold shuts and inclusions

3) Inclusions and laps

4) Pipes or voids

i. Which statement relating to the residual magnetizing inspection method is true?

1) It requires careful and intelligent interpretation and evaluation of the discontinuities it reveals

2) It is used in practically all circular and longitudinal magetizing procedures

3) It may be used only with steels which have been heat-treated for stressed applications

4) Its indicating medium is applied when the magnetizing force is being maintained

j. What method of magnetic particle inspection is used most often to inspect aircraft parts for invisible cracks and other defects?

1) Residual

2) Inductance

3) Continuous

4) Intermittent

k. Which method of magnetization produces the greatest sensitivity in locating subsurface discontinuities?

1) Continous circular with a solenoid

2) Continuous longitudinal with a solenoid

3) Residual circular with a conductor bar

4) Residual longitudinal with a conductor bar

l. The magnetic particle inspection is somewhat unreliable for distinguishing or detecting

1) Laps and fatigue cracks

2) Cold shuts

3) Hairline discontinuities and small cracks

4) Discontinuities which are below the surface

THEORY TEST

35. Perform a magnetic particle inspection.

(NOTE: Test question 35 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.

36. State facts related to eddy current inspection. Write the correct answers in the blanks.

a. What are the two methods of eddy current inspection?

1) ________________________________

2) ________________________________

b. What is the basic principle upon which eddy current inspection operates? ________________________________

____

____

c. What are the four characteristics of a metal that determine its ability to accept eddy currents?

1) ________________________________

2) ________________________________

3) ________________________________

4) ________________________________

d. Which type of corrosion is the eddy current method of inspection most successful in detecting?

____

____

37. State the principle of operation of an ultrasonic inspection.

____

____

____

____

____

38. Select statements related to X-ray and gamma ray radiographic inspection. Circle the numbers before the correct answrs.

    a. What is the principal advantage of the radiographic inspection method of nondestructive testing?

        1) Minimum safety precautions required

        2) Little or no disassembly of structure

        3) Simplicity of equipment operation

        4) Low cost

    b. Which of the following factors is considered basic knowledge of X-ray exposure?

        1) The X-ray unit's capabilities and its proper operation

        2) The density, thickness, size, and shape of the object to be exposed

        3) The distance and angle for 1-minute exposure

        4) The type and exact size of the discontinuity to be detected

    c. Which of the following nondestructive inspection methods would be most suitable for inspecting wing internal structures?

        1) Continuous magnetic particle inspection

        2) Penetrant inspection

        3) Radiographic inspection

        4) Residual magnetic particle inspection

    d. How are gamma rays produced?

        1) By using an electronic accelerator

        2) By current applied to an atomic intensifier tube, which then emits gamma rays

        3) By exposing a substance to an unstable hydrogen atmosphere

        4) By the disintegration of radioactive isotopes

e. What is the best material for shielding radiated energy?

1) Dense iron

2) Lead

3) Concrete

4) Laminated layers of glass and monel mesh

39. Select statements related to visual inspection of welds. Circle the numbers before the correct answers.

a. What is the most important characteristic that contributes to a sound weld?

1) Inclusions

2) Fusion

3) Puddling

4) Porosity

b. One characteristic of a good weld is that no oxide should be formed on the base metal at a distance from the weld of more than

1) 1/4 inch

2) 1 inch

3) 1/8 inch

4) 1/2 inch

c. Which of the following is an unacceptable characteristic of a weld on an aircraft?

1) Projecting globules

2) Smooth seam

3) A smooth taper into the base metal

4) An extra thickness built up at the joint

d. Holes and a few projecting globules are found in a weld. What action should be taken?

1) Fill the holes with solder

2) Reheat the bead to melt the globules

3) Remove all the old weld and reweld the joint

4) File the rough surface

e. Select a characteristic of a good gas weld.

1) The depth of penetration shall be sufficient to ensure fusion of the filler rod

2) The weld should be built up 1/8 inch

3) The weld should taper off smoothly into the base metal

4) No oxide should be formed on the base metal

40. List the basic characteristics of a good weld. Write the correct answers in the blanks.

a. ______________________________

b. ______________________________

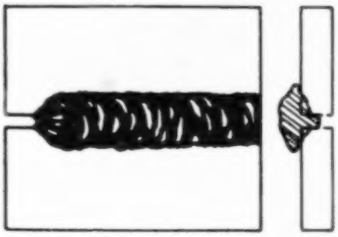
c. ______________________________

d. ______________________________

e. ______________________________

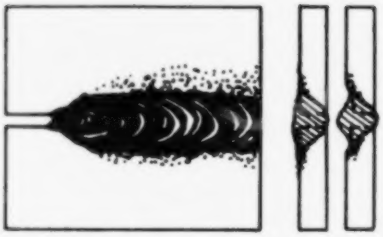
41. Identify types of welding defects when given pictorial drawings and sectional views. Write the correct answers in the blanks.

a.



1) ______________________________

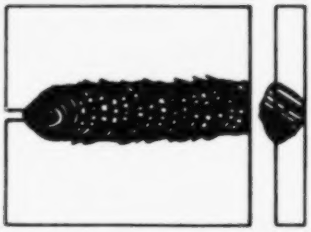
b.



1) ____

2) ____

c.



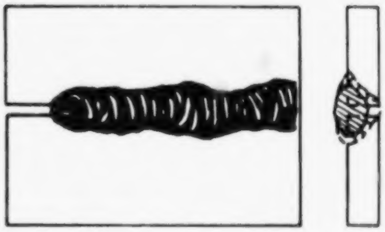
1) ____

2) ____

3) ____

4) ____

d.



1) ____

2) ____

42. Perform visual inspections of welded assemblies.

(NOTE: Test question 42 is a project guide. It is an important part of this test. If it has not been completed, check with your instructor.)

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

ANSWERS TO THEORY TEST

1.

a.	9	g.	5	m.	11
b.	6	h.	3	n.	10
c.	8	i.	4	o.	16
d.	2	j.	12	p.	14
e.	1	k.	17	q.	13
f.	7	l.	15		

2. a. First, all the carbon is removed, and then under controlled conditions, a small amount of carbon is replaced

   (NOTE: Replace to about 1.7%.)

   b. The high weight per unit of volume of steel restricts their use of highly stressed fittings and truss frame assemblies

   c. 1. Light in weight
      2. Highly resistant to corrosion

3. a. Germany
   b. By annealing
   c. Only by cold working (or strain hardening)
   d. Both hardening and softening can be accomplished using heat
   e. They are susceptible to corrosion
   f. Pure aluminum layers on an aluminum alloy core

4.

a.	N	e.	N
b.	H	f.	H
c.	H	g.	H
d.	N	h.	H

5. a. 10 minutes

   b. They should be reheat-treated

   c. The corrosion resistance of the material will be impaired

   d. One to three times

ANSWERS TO THEORY TEST

e. Because of the increased diffusion of core and cladding with each reheating

f. The material is held at an elevated temperature at which the alloying agents enter into a uniform solid solution with the matrix of the base metal. Then, it is removed and rapidly quenched

g. A material is heated to a temperature below the temperature required for solution-heat treatment, and held at this temperature for a given period of time. When removed from heat, metal is allowed to cool in still air

h. 1) 500°F
   2) 50°F per hour
   3) no

6.

a.	6	d.	8	g.	9
b.	1	e.	4	h.	5
c.	3	f.	2	i.	7

7. a. 3
   b. 4

8. a. It is a metal that retains its strength and corrosion resistance at elevated temperatures

   b. The titanium must be blanketed with an inert gas such as helium or argon to prevent the titanium from combining with oxygen

9. a. Monel
   b. Hot-section parts
   c. Because of its ability to maintain its strength and corrosion resistance under extremely high temperatures

10. a. Bronze
    b. Bushings and bearing surfaces
    c. Copper tubing becomes brittle when subjected to vibration

11.

a.	5	e.	8	i.	7
b.	3	f.	9	j.	4
c.	1	g.	11	k.	10
d.	2	h.	6		

ANSWERS TO THEORY TEST

12. a. 3
b. 4
c. 4
d. 4
e. 2
f. 3

13. a. 1
b. 2
c. 4
d. 3
e. 1

14. a. It will return to its original state
b. A mechanical mixture
c. 1,000°F

15. a. 1
b. 4
c. 1

16. Evaluated to the satisfaction of the instructor

17. a. 2
b. 3
c. 1

18. a. 5
b. 6
c. 2
d. 3
e. 1
f. 7
g. 4

19. a. One in fifteen

b. Place some free-flowing ink on the wood; it will follow the fibers in the wood and make the grain visible

c. A knot is a portion of a branch that is part of the trunk of the tree

d. A split is a lengthwise separation of the wood caused by the wood fibers tearing apart

e. A check is a crack that runs across the annual rings of a board

f. Pick at the wood with the point of a knife blade. If the wood splinters, it is sound. If the wood is decayed, it will come up as a chunk

g. A compression failure appears as an irregular thread-line across the grain

20. a. Thermoplastic
    b. Thermosetting

21. a. 3
    b. 1
    c. 2
    d. 4
    e. 3
    f. 1

22. Performance skills evaluated to the satisfaction of the instructor

23. a. 2
    b. 1
    c. 6
    d. 4
    e. 3
    f. 5
    g. 11
    h. 8
    i. 9
    j. 12
    k. 10
    l. 7
    m. 18
    n. 14
    o. 16
    p. 15
    q. 13
    r. 17

24. Evaluated to the satisfaction of the instructor

25. a. Nothing can be inspected unless it is uncovered and made visible

    b. A fiberoptic borescope is an optical instrument that allows us to look into an inacessible location through a bundle of glass fibers

26. a. Cleaning
    b. Penetrant application
    c. Removal of excess penetrant
    d. Application of developer

27. a. 2
    b. 4
    c. 1
    d. 3
    e. 4
    f. 1

ANSWERS TO THEORY TEST

28. a. 2
    b. 3
    c. 1

29. Performance skills evaluated to the satisfaction of the instructor

30. a. All of the magnetic fields, or domains, within the material are aligned when the part is magnetized

    b. Gauss

    c. When the conductor is wound into a coil, the lines of flux are concentrated within the coil and the strength of the magnetic field is increased

31. a. 4
    b. 3
    c. 6
    d. 1
    e. 5
    f. 2

32. a. 1
    b. 1
    c. 3
    d. 2

33. a. Zero
    b. On the surface of the conductor
    c. 1) Direct current
       2) Half-wave rectified direct current
       3) Alternating current

34. a. 3
    b. 4
    c. 1
    d. 3
    e. 3
    f. 2
    g. 4
    h. 4
    i. 3
    j. 3
    k. 2
    l. 4

35. Performance skills evaluated to the satisfaction of the instructor

36. a. 1) Absolute method
       2) Comparison method

    b. Eddy current inspection depends upon the principle of determining the ease with which a material will accept an induced current

- c. 1) Conductivity
  - 2) Permeability
  - 3) Mass
  - 4) Presence of any voids or faults
- d. Intergranular corrosion

37. The condition of a material is determined by its ability to conduct sound wave vibrations which occur at frequencies above those to which the human ear responds

38. a. 2
    - b. 1
    - c. 3
    - d. 4
    - e. 2

39. a. 2
    - b. 4
    - c. 1
    - d. 3
    - e. 3

40. a. Uniform in width
    - b. Even and well-feathered ripples
    - c. No burn marks due to overheating
    - d. Good penetration
    - e. Free of gas pockets, porosity, and inclusions

41. a. Improper penetration
    - b. 1) Excessive oxidation
      - 2) Too much heat
    - c. 1) Puddle boiled
      - 2) Excessive acetylene; porosity holes
      - 3) Crater at finish
      - 4) Bumps along edge
    - d. 1) Irregular edges
      - 2) Variation in penetration

42. Performance skills evaluated to the satisfaction of the instructor

PRACTICAL TEST #1--Perform a Liquid-Penetrant Inspection

INSTRUCTOR'S GUIDE

I. STUDENT ACTIVITY--The student will be required to perform a liquid penetrant inspection in accordance with FAA and industry standards. The student must use the correct references, select the correct penetrants, and determine the number, size, and location of the defects within specified time limits and using proper safety procedures.

II. PROCEDURE

A. Select parts with surface and subsurface defects

B. Review the evaluation form

C. Have the student provide you with the practical test guide and evaluation form from the student guide

(NOTE: For reference, a copy of the student guide has been placed in the instructor's guide.)

D. Fill out the student evaluation guide for the assigned parts

E. Provide the student with the parts and student evaluation guide

F. Provide the student with a selection of possible manuals to be used in this procedure, including the required manuals

G. Provide the student with possible tools and equipment to use in the procedure, including all required tools

H. Monitor the student's performance and record the results on the evaluation form

I. Inspect the work when completed

J. Calculate scores on evaluation form and determine student rating

K. Discuss the student's performance

L. Reteach and retest as necessary

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

PRACTICAL TEST #1--Perform a Liquid-Penetrant Inspection

STUDENT GUIDE

I. INTRODUCTION: The safe and efficient operation of an aircraft requires careful inspection of different types of materials and ferrous types of materials and parts. In this practical test, you will be required to inspect ferrous types of metals and determine defects. You will be required to determine types of penetrant for adequate inspection. To pass this test you must determine the size, location, and number of defects within the allotted time.

II. PART TO BE INSPECTED: ____________________

III. REQUIRED MANUALS: ____________________

____

____

IV. NUMBER OF DEFECTS: ____________________

V. SIZE AND LOCATION OF DEFECTS:

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

PRACTICAL TEST #1--Perform a Liquid-Penetrant Inspection

NAME: ______________________________ DATE: ____________________

Performance evaluation key

Student's performance is typical of an:		Point value
A = Exceptionally competent worker	=	5
E = Incompetent worker	=	1

Degree of importance factors

To be multiplied by performance evaluation key letter value

(NOTE: All steps in this process are Critical. They will be rated at a degree of importance factor of 5.)

5 = Performed
4 = Essential
3 = Important
2 = Necessary
1 = Did not perform

(NOTE TO EVALUATOR: Circle the appropriate numbers earned and make the necessary calculations to determine score.)

Item No.		PROCESS (175 pts. possible) A	E				
1.	Cleaned part to be inspected	5	1	x	5	=	_____
2.	Selected the correct liquid penetrant	5	1	x	5	=	_____
3.	Selected the correct developer	5	1	x	5	=	_____
4.	Applied liquid penetrant correctly	5	1	x	5	=	_____
5.	Applied developer correctly	5	1	x	5	=	_____
6.	Followed approved data correctly	5	1	x	5	=	_____
7.	Followed proper safety procedures	5	1	x	5	=	_____
		Total process score				=	_____

PRACTICAL TEST #1

Item No.		PRODUCT (75 pts. possible)				
		A	E			
8.	Seventy percent of defects were identified	5	1	x 5	=	______
9.	Determined correct size of defects	5	1	x 5	=	______
10.	Used time economically	5	1	x 5	=	______

Total product score = ______

Total process score = ______

Total product score + ______

Total test score = ______

(NOTE: You must receive an "A" rating on item numbers 1-9. If those items are passed, then the acceptable passing score is 225.)

PRACTICAL TEST #2--Perform a Magnetic Particle Inspection

INSTRUCTOR'S GUIDE

I. STUDENT ACTIVITY - The student will be required to perform a magnetic particle inspection in accordance with FAA and industry standards. The student must use the correct references, select the correct magnetic particle mediums, and determine the number, size, and locations of the defects within specified time limits and using proper safety practices.

II. PROCEDURE

A. Select parts with surface and subsurface defects

B. Review the evaluation form

C. Have the student provide you with the practical test guide and evaluation form from the student guide

(NOTE: For reference, a copy of the student guide has been placed in the instructor's guide.)

D. Fill out the student evaluation guide for the assigned parts

E. Provide the student with the parts and student evaluation guide

F. Provide the student with a selection of possible manuals to be used in this procedure, including the required manuals

G. Provide the student with possible tools and equipment to use in the procedure, including all required tools

H. Monitor the student's performance and record the results on the evaluation form

I. Inspect the work when completed

J. Calculate scores on evaluation form and determine student rating

K. Discuss the student's performance

L. Reteach and retest as necessary

GENERAL

G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE

IDENTIFY STRUCTURAL MATERIALS AND PERFORM VISUAL, DYE-PENETRANT, AND MAGNETIC PARTICLE INSPECTIONS

G102-D

PRACTICAL TEST #2--Perform a Magnetic Particle Inspection

STUDENT GUIDE

I. INTRODUCTION: The safe and efficient operation of an aircraft requires careful inspection of different types of materials and parts. In this practical test you will be required to inspect ferrous types of metals and determine defects. You will be required to determine the type of magnetic particle medium for adequate inspection. To pass this test you must determine the size, location, and number of defects within the allotted time.

II. PART TO BE INSPECTED: ______________________________

III. REQUIRED MANUALS: ______________________________

____

____

IV. NUMBER OF DEFECTS: ______________________________

V. SIZE AND LOCATION OF DEFECTS:

GENERAL
G102 FUNDAMENTALS OF AIRCRAFT MAINTENANCE
IDENTIFY STRUCTURAL MATERIALS AND PERFORM BASIC MATERIAL PROCESSES
G102-D

PRACTICAL TEST #2--Perform a Magnetic Particle Inspection

NAME: ____ DATE: ________________

Performance evaluation key

Student's performance is typical of an:		Point value
A = Exceptionally competent worker	=	5
E = Incompetent worker	=	1

Degree of Importance Factors

To be multiplied by performance evaluation key letter value

(NOTE: All steps in this process are critical. They will be rated at a degree of importance factor of 5.)

5 = Critical
4 = Essential
3 = Important
2 = Necessary
1 = Least important

(NOTE TO EVALUATOR: Circle the appropriate numbers earned and make the necessary calculations to determine score.)

Item No.		PROCESS (175 pts. possible)					
		A	E				
1.	Cleaned part to be inspected	5	1	x	5	=	________
2.	Selected the correct magnetization procedure	5	1	x	5	=	________
3.	Selected and used the correct operations manual	5	1	x	5	=	________
4.	Selected correct type of magnetic particle medium	5	1	x	5	=	________
5.	Performed magnetic particle application correctly	5	1	x	5	=	________
6.	Demagnetized part properly	5	1	x	5	=	________
7.	Worked safely	5	1	x	5	=	________
		Total process score				=	________

PRACTICAL TEST #2

Item No.		PRODUCT (100 pts. possible)					
		A	E				
8.	Determined existence of surface or subsurface defects	5	1	x	5	=	________
9.	Seventy percent of defects detected	5	1	x	5	=	________
10.	Determined correct size of defects	5	1	x	5	=	________
11.	Used time economically	5	1	x	5	=	________

Total product score = ________

Total process score = ________

Total product score + ________

Total test score = ________

(NOTE: You must receive an "A" rating on item numbers 1-10. If those items are passed, then the acceptable passing score is 250.)